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A GREAT WINTER SANITARIUM FOR THE AMERICAN CONTINENT.

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THE great importance of a winter sanitarium for patients suffering from or threatened with consumption and other allied diseases has long been recognized and acted upon in Europe. The favorite resort of this description is the valley of Davos, in the Engadine, in Switzerland, where, at an elevation of five thousand four hundred feet above sea-level, the patients enjoy, during the winter months, in a sheltered position, brilliant sunshine, and an early equable sun-temperature from sunrise to sunset.

Dr. Hermann Weber, one of the highest authorities in Europe on chest-diseases, thus summarizes the physiological effects of the climate of Davos :

1. Increased activity of the skin, better nutrition, and invigoration of the skin.

2. Strengthening of the heart and the contractile fibers of the vascular system, with augmented frequency of the heart's contractions at first, but reversion to the normal state after a longer sojourn, together with greater force of each contraction, and thereby increased suction-power.

3. More rapid respiration at first, but return to the normal rate after a few days. Probable increase of depth of inspirations. Strengthening of the respiratory muscles, and probably also of the elastic fibers of the finest bronchial branches. Increased flow of blood through the lungs.

4. Generally a marked increase in the excretion of water through the lungs, and increased and facilitated excretion of carbonic acid.

5. In most cases, transient or continued increase of appetite, ingestion of food, digestion and assimilation.

6. Thereby improved production of blood and nutrition of the organs.

7. Greater energy of nervous and muscular action.

8. In most cases, improvement of sleep.

9. Probable augmentation of tissue-change.

During last fall I became acquainted with an elevated plateau in the United States which rivals if it does not even surpass Davos in the excellence of its winter climatic conditions. I allude to that most interesting tract of territory — the Yellowstone National Park.

The beneficial effects of a winter climate like that of Davos depend upon the concurrence of several conditions which are difficult to secure at a lower elevation than that just indicated. In the first place, the sun's rays are far more powerful at great than at low elevations, and their intensity is much more equable throughout the day; thus the temperature in sunshine observed by me at Davos on the 26th of December was 89·2° Fahr. twenty-five minutes after sunrise, 108·5° Fahr. at noon, and 91·6° Fahr. at thirty-five minutes before sunset. And the intensity of solar radiation at Davos is such that, on the 22d of December, I obtained, in a box lined with padded black cloth and covered with plate-glass, a temperature of 221° Fahr., or 21° above the boiling-point of water at Davos (200° Fahr.).

Besides the intensity of solar radiation and its comparative uniformity during the day, the rarity and calmness of the air are important factors among the causes of the peculiar climate of Davos. With the barometer standing at 615 millimetres, the weight of air in contact with a given surface of the skin is about one fifth less than it is at the sea-level. The excessive dryness of the air at Davos has probably but little special influence upon the sensation of heat and cold, because the maximum proportion of aqueous vapor present in air near the freezing-point is everywhere small, and the specific heats of equal volumes of air and aqueous vapor are not widely different. On the other hand, the absence of suspended watery particles in the air has, no doubt, very considerable influence in preventing the chilling of the skin. Not only are such liquid particles present when there is visible fog, but they often exist in great numbers when the air presents a perfectly transparent appearance. The most important influence upon the sun-temperature, however, is the reflection of solar rays from the snow. The valley of Davos has precipitous sides and a flat sole, and the hotels are situated on the northwest slope of the valley; consequently they receive, in winter, the scattered solar rays reflected from a large area of snow. A considerable proportion of the thermal rays of the sun falling at an acute angle upon a surface of snow is known to be reflected.

It is obvious that this action of extensive reflecting surfaces of snow must exert a powerful influence upon the maximum temperature of places favorably situated for receiving the reflected rays; and, moreover, where the proportion of heat reflected varies (as it has been proved to do in the case of water, and as it doubtless also does in the case of snow) inversely as the angle formed by the incident rays and the reflecting surface, this action must materially contribute, especially in winter, to the maintenance of an approximately uniform sun-temperature throughout the day. At Davos, and similar elevated stations, however, the comparative freedom of the air from suspended particles must, to a great extent, contribute to such a result; for, as pure and dry air is transcalent and reflects heat but very slightly, the horizontal sunbeams, passing through such air, would be nearly as powerful as vertical rays.

The peculiar winter climate of Davos depends, therefore, upon the following conditions:

1. ELEVATION ABOVE THE SEA.—This single condition favors a genial and wholesome winter climate in several ways. In the first place, by reducing the weight of cold air in contact with the body, whereby, even with a much lower thermometer, the air, if still, feels warmer at an elevated station than in the lower and denser regions of the atmosphere, in consequence of the slower abstraction of heat from the body. In the second place, the air at great altitudes is more permeable to the heating rays of the sun, owing both to its dryness and to its freedom from dust and suspended particles generally. In illustration of this I have made many experiments, chiefly in England and Switzerland, and an abstract of the results obtained is given in the following table:

PLACE OF OBSERVATION.	Elevation above sea-level.	Sun's altitude.	Sun-temperature.	Air-temperature.
	Feet.	Degrees.	Degs. Fahr.	Degs. Fahr.
Oatlands Park, Surrey	150	60	74·7	86·0
Riffelberg, Zermatt	8,428	60	81·9	76·1
Hörnli, Zermatt	9,491	61	86·6	68·2
Gornergrat, Zermatt	10,289	61	84·6	57·6
Whitby, Yorkshire	60	50	68 0	90·0
Pontresina, Engadine	5,915	49	79·2	79·7
Bernina Hospitz, Engadine	7,644	51	83·5	66·4
Diavolezza, Engadine	9,767	50	107·1	42·8

It is thus evident that, although the air-temperature continually decreases as we ascend, the sun-temperature as regularly augments. The horizontal line in the table divides the observations into two groups, in each of which the sun's altitude was approximately the same. In these, and similar observations described further on, the air-temperature was found by placing an ordinary mercurial thermometer upon a

sheet of white paper and shading its bulb with a small arch of similar paper doubled, the sun-thermometer (blackened bulb *in vacuo*) was also placed either upon white paper or upon snow, and the numbers in the column headed "sun-temperature" were obtained by deducting the readings of the air or shade thermometer from those of the sun-thermometer. Thus, on the Diavolezza, the reading of the air-thermometer (42·8°), being subtracted from the reading of the sun-thermometer (149·9°), left the number 107·1° as the sun-warmth, or the temperature, above that of the surrounding air, to which the sun's rays raised the blackened bulb *in vacuo*.

The very high sun-temperature observed on the Diavolezza was recorded at a station surrounded by snow-fields in brilliant sunshine, and the thermometer was placed upon snow.

Not only is solar radiation much more intense at great altitudes, but it is also more equable during the whole day, inasmuch as the comparative absence of suspended matters in the air renders the thermal power of the rising and setting sun more nearly equal to that of the meridional sun. Thus it has been observed that, at or near the sea-level, the sun-temperature increases about 15° Fahr. between 8.30 A. M. and noon, and decreases to the same extent between noon and 3.30 P. M.; whereas on the Riffelberg, 8,428 feet above the sea, the increase and decrease between the same hours are only 9° Fahr. These observations were, however, made in summer; in winter, the difference between the two stations would doubtless be still greater. Moreover, an elevation of 5,000 or 6,000 feet places us, especially in winter, to a great extent above the region of cloud, and thus enables us to enjoy a bright sun at time when clouds effectually cut off his rays from lower altitudes.

Lastly, and this is of the highest importance to invalids, the air at great elevations is characterized by comparatively great freedom from zymotic matters. By numerous and ingenious experiments Pasteur found this to be the case at a height of 6,300 feet, on the slope of Mont Blanc, and Tyndall at an elevation of 6,730 feet, on the Bel Alp, in Switzerland.

2. REFLECTION FROM SNOW.—Although the air-temperature in mid-winter, at elevations of from 5,000 to 10,000 feet, differs but little from that of much lower levels in the same localities, the low temperature prevails for a longer time. Thus the valley of Davos and the surrounding mountains are usually thickly covered with snow from November to the beginning of March, and the solar heat reflected from this snow is an important factor in the production of the genial winter climate of Davos. By laying a sun-thermometer on surfaces of different materials, I have demonstrated the high reflective power of snow. The following summary of the results of these experiments shows the degrees to which the blackened bulb *in vacuo* was raised when laid in the sunshine upon each of the materials experimented with:

White paper	116·6°	Fahr.
White linen	116·1	"
Snow	111·0	"
Metallic mirror	97·5	"
Common mirror	97·5	"
Light-colored soil	96·3	"
Parched grass	95·3	"
Gray rock	88·4	"
Green grass	88·2	"
Black silk	84·0	"
Black caoutchouc	82·2	"
Black merino	80·4	"

White paper and white linen were therefore the most perfect reflectors of solar heat; but the efficiency of snow was but slightly inferior, while it greatly surpassed that of even polished metal.

The relative proportions of direct and reflected solar heat, falling upon a body in sunshine surrounded with snow, has not been determined, although it has been ascertained where water is the reflecting surface. Thus, M. Dufour has measured the proportions of direct and reflected solar heat incident at five different stations on the northern shore of the Lake of Geneva. He found that the proportion of reflected heat was as much as sixty-eight per cent of the heat directly incident from the sun, when the sun's altitude was between 4° 38′ and 3° 34′. At about 70° altitude, the proportion was between 40 and 50 of reflected to 100 of direct heat; and, even at an altitude of 16°, the proportion was between 20 and 30 of reflected to 100 of direct heat; but when the sun was higher than 30° the reflected heat was hardly appreciable. My own observations confirm these results, for I found at Alum Bay, Isle of Wight, that the reflection from a ruffled sea, at 6.45 P. M., in May, added no less than forty-four per cent to the direct solar heat.

It is obvious, therefore, that the Davos sanitarium is much indebted to its snow-covered valley for a winter day-climate which is so genial as to allow the patients to spend nearly the whole of every sunny day in the open air, although the temperature of the air may be 15° or 20° below the freezing-point. Five minutes after sunrise, many of the patients walk in the open air without any special wraps, and some of them even without overcoats. In the brilliant sunshine, one feels comfortably warm sitting in front of the hotel in a light morning coat.

3. FREEDOM FROM AIR-CURRENTS.—Davos is well sheltered from general atmospheric movements, and, as the surrounding snow can not be warmed above the freezing-point, no local currents or valley-winds can be set up. An almost uniform calm, therefore, prevails during the continuance of snow. This immunity from air-currents is of the highest importance to the patients, for, without it, they would not be able to sit out-of-doors and enjoy the free and comparatively germless air as already described. In still though cold air the skin is less chilled

than in much less cold air which impinges with considerable velocity upon the surface of the body. The effect of motion through the air upon the sensation of warmth and cold at Davos is very striking. Sitting perfectly still in the sunshine, the heat in midwinter is sometimes almost unbearable; on rising and walking about briskly, a delicious feeling of coolness is experienced; but, on driving in a sledge, the cold soon becomes painful to the unprotected face and hands.

Such are the conditions prevailing at Davos, and producing the delightful climate of this winter resort. They may be thus briefly summarized: 1. Great elevation above sea-level; 2. A continuous, and, during winter, permanent covering of snow; 3. A minimum of watery vapor in the air; 4. A clear sun; 5. A clean atmosphere, free from zymotic germs, dust, and fog; 6. A sheltered position, favorable for receiving both the direct and reflected solar rays.

I have been thus particular in describing these conditions in order to make clear the capability of the Yellowstone plateau to provide a similar beneficent winter climate for invalids.

From my own observations, and from inquiries made on the spot, I am of opinion that the Yellowstone National Park possesses, in a high degree, all these essential conditions. In elevation above the sea it surpasses Davos; the great plateau of the park is between 7,000 and 8,000 feet above sea-level, while it is stated that not one of the narrow valleys dips below 6,000 feet. The mountain-ranges, partly surrounding and partly within the park, rise to heights of from 10,000 to 12,000 feet. I should anticipate, therefore, that all the advantages which, as a winter resort for invalids, Davos possesses from its elevated position, would be enjoyed even in a greater degree in the Yellowstone Park. The period of permanent snow is longer, so that invalids could remain there probably until the end of April, whereas the melting of the snow generally compels them to leave Davos early in March, when the climate of the valleys is peculiarly unfavorable for chest-complaints. It is to be expected, from its greater elevation, that a still clearer sky and a larger proportion of sunny days would be experienced in the Yellowstone Park, while the wholesomeness of the air would be still more marked, owing to its comparatively greater freedom from zymotic matter.

The latitude of Davos is 47°, and the Yellowstone Park lies almost entirely between the forty-fourth and forty-fifth parallels. The winter temperature at Davos varies from 32° Fahr. down to 22° Fahr., and that of the park would probably observe nearly the same extremes. The selection of suitable sites for hotels and sanitary dwellings is, of course, of the highest importance. The only hotel at present existing—the Mammoth Hot Springs Hotel—is not favorably situated, but, even in my comparatively limited excursions in the park, I saw numerous most eligible sites for such establishments—sites sheltered from northerly winds, either by abruptly elevated ground or pine-forest, with a

wide expanse of prairie to the south. A free horizon southward is of great advantage to a winter climate, not only because the practically unlimited surface of snow secures the most perfect reflection of solar warmth, but also because there is no obstruction to the rays of the rising and setting sun. I consider the want of a free southern horizon to be an important defect in the situation of Davos, for it reduces in winter the daily period of sunshine by more than two hours, or, in other words, it diminishes the length of day available for patients in midwinter by more than one fourth. In respect of daily duration of sunshine, therefore, the advantage of the park over Davos would be considerable.

In order, however, that it may be fitted for the reception of invalids, much will have to be done besides the building of hotels. The lawlessness and extortion which at present prevail throughout the Yellowstone National Park must be made to cease, wholesome food must be substituted for the indigestible material which now does duty for beef and mutton, and the almost impassable roads must be seriously taken in hand.

The one drawback to the park is its great distance from the masses of the American population ; but, in the first place, distances which are almost prohibitive to travelers in Europe are thought little of in America ; and, secondly, the comfortable, not to say luxurious, traveling on American lines would render the transit from the Eastern cities of the United States scarcely more formidable than that from London to Davos, the driving portion of the journey being, in fact, much shorter in the American route.

We are as yet too little acquainted with the chemical composition of the hot springs, geysers, and mineral waters so profusely distributed throughout the park, to form any trustworthy opinion of their medicinal virtues, but the *physical* properties of water are much the same everywhere, and, by a judicious selection of sites, the enormous advantages of an unlimited supply of natural hot water and steam for baths and heating purposes could easily be secured, and this without interfering with the wonders and æsthetic beauties of this most extraordinary and interesting region.

At present, the park, so generously set apart by Congress for the enjoyment of the American people, is utilized only by a very limited number of tourists, in the few months of a very short summer, and it seems a pity that such a magnificent possession should not be much more extensively used. Dedicated during the winter months to the purposes I have here advocated, it would constitute a winter sanitarium unequaled in the world, restoring to health and vigor not only thousands of persons suffering from incipient chest-diseases, but also still greater numbers of the overworked populations of the States and Canada.

RECENT PROGRESS IN AËRIAL NAVIGATION.

By Professor W. LE CONTE STEVENS.

BALLOONING has thus far been a French art: introduced a little over a century ago by a Frenchman, Montgolfier; rapidly developed by another Frenchman, Charles; more practiced in France than anywhere else in the world; and recently improved by Frenchmen to such an extent that it is quite possible now on any fair day to go an hour's journey through the air in any desired direction, even against the wind.

The history of the application of science to art has revealed a number of cases in which practical success was secured by inventors entertaining quite erroneous conceptions of the principles they were applying. Somewhat vague stories are transmitted in regard to Roger Bacon's suggestion, during the thirteenth century, of employing a thin hollow globe of copper, "to be filled with ethereal air or liquid fire and then launched forth from some elevated point into the atmosphere, where it will float like a vessel on water." Bacon gave no recipe for making "liquid fire," nor did he calculate the dimensions of a globe of copper to be filled with it that would have sufficient ascensive power to lift a human being. He assures us "there is certainly a flying instrument, not that I ever knew a man that had it, but I am particularly acquainted with the ingenious person who contrived it." His conception was never reduced to practice. It was merely a fair specimen of current science in his time. He believed that the aërial ocean around our earth had a definite boundary like the liquid ocean, and that a body of sufficient lightness, if it could only be found, would easily rise to this surface as a cork rises to the surface of water.

More than three centuries after the time of Bacon, Father Lana wrote out his idea of a vessel that might be made to rise in the air. Four hollow globes of copper, each having a diameter of about twenty-five feet, were to be carefully exhausted and then attached to a car. Torricelli and Pascal had already proved that the pressure of the atmosphere was nearly fifteen pounds per square inch at sea-level, and Lana's proposed method of exhausting his globes was to be an application of Torricelli's principle. Each globe was to be filled with water and lifted to a height of at least thirty-four feet. Beneath it should be fitted a tube with air-tight connections, which was to dip into water. On opening this tube the contents of the globe would be emptied into the vessel below, leaving a Torricellian vacuum above, while the tube would become a water-barometer. Lana seemed to know nothing about the specific gravity of gases. His copper globes were to be made very thin in order to secure lightness, but he failed to make any correct estimate of the rigidity they must have to sustain either the

weight of the water they should hold, or the crushing force of the atmosphere after exhaustion. Unlike the product of Bacon's imagination, his conception was a correct application of demonstrated physical laws; but, had it been tested by experiment, he would at once have found that there were other laws which he had not taken into account. In his view, the only obstacle to success was that "the Almighty would never allow an invention to succeed by means of which civil government could so easily be disturbed." Air-ships floating beyond the reach of missiles, if only capable of being accurately directed, might well have been thought more terrible than dynamite is to-day.

Soon after the discovery of hydrogen gas by Cavendish and Watt in 1766, experiments were made with a view to utilizing it for the purpose of lifting bodies into the air. But, until 1783, nothing more substantial than a soap-bubble could be made thus to ascend. Joseph Montgolfier, who was a successful manufacturer of paper, tried bags of this material; but hydrogen was found to diffuse so rapidly through it that the idea was abandoned by him. Observing that clouds of vapor and smoke remained floating at various heights, he thought that, if they could be confined in bags of paper, these might be made to float in like manner. Since the experiments of Franklin in 1752 had proved the existence of atmospheric electricity, the idea gained currency that the lightness of clouds and of smoke was in some way due to electric charge. A paper bag was made, and, with its opening downward, a fire was kindled, "as well to increase the layer of electric fluid upon the vapor in the vessel as to divide the vapors into smaller molecules and dilate the gas in which they are suspended." The bag was carried up to a considerable height. Montgolfier seems not to have attributed the ascension to the effect of heat in diminishing the specific gravity of the contained air. The first successful experiment in ballooning was thus based on a misconception.

Montgolfier's first public exhibition of his invention was made on June 5, 1783. The news of his success was rapidly spread; and at Paris a balloon was soon constructed under the superintendence of M. Charles, who substituted hydrogen for smoke, confining it in a bag of varnished silk instead of paper and linen. The ascension was successfully accomplished on the 27th of August. Charles at once proceeded to the construction of a new and much larger balloon, in which he ascended with his colleague, Robert, on the 1st of December, making a journey of more than twenty-five miles. This balloon was provided with a safety-valve of Charles's invention, a hoop, to which the car was attached, and netting intended to equalize the distribution of weight upon the balloon. It was in all important particulars the same as the balloon almost universally employed throughout a century afterward. Montgolfier made several exhibitions of his hot-air balloons at Paris, and in one of these, on the 15th of October, M. Pilâtre de

Rozier made the first ascent attempted by a human being. But to Charles is due the credit of making the balloon a moderately safe vehicle in which the aëronaut could ascend or descend at will by varying the relation between the amounts of ballast and of gas retained. Although many thousands of ascents have been made since 1783, the total number of lives recorded to have been lost does not exceed fifty.

It is somewhat remarkable that after the ascents made by Pilâtre de Rozier and others at Paris in the latter part of 1783, the first ascent accomplished elsewhere was in America, a country not only separated by a broad ocean from France, but at that time young in resources, and scarcely beginning to recover from the disastrous effects of the struggle for independence. It is true that in November of that year an Italian, Count Zambeccari, exhibited in London a small hydrogen balloon, which was sent into the air without any living freight; but no one rose from English ground in a balloon until a year after Charles had been successful in France. The news of Montgolfier's experiment of the 5th of June reached Philadelphia about the last of November, and the local newspapers of December 24th contained the accounts just received in regard to Charles's experiment of the 27th of August. David Rittenhouse, the friend of Franklin, and the most distinguished American astronomer of his time, was practicing his profession as a maker of philosophical instruments, and especially of clocks. One of his most intimate associates was Francis Hopkinson, an eminent jurist, whose interest in science was almost as great as in law. Both of these men were members of the American Philosophical Society which had been organized by Franklin. No sooner was the news from France received, than they began to test the use of hydrogen for balloons. On the 28th of December an ascent was made by the first American aëronaut, the account of which is perhaps best given in the language of an eye-witness, François Simonin, whose letter to the "Journal de Paris" was published May 13, 1784. In the "Gentleman's Magazine" of the following month a translation of it appeared, from which the following is an extract: "Messieurs Ritnose [Rittenhouse] and Opquisne [Hopkinson] began their experiments with bladders, and then with larger machines; they joined several together and fastened them round a cage, into which they put animals. The whole ascended, and was drawn down again by a rope. The next day, which was yesterday, a man offered to get into the cage, provided the rope was not let go. He rose about fifteen feet, and would not suffer them to let him go higher. James Wilcox, a carpenter, engaged to go in it for a little money. He rose twenty feet or upward before he made a signal to be drawn down. He then took instructions from Messieurs Ritnose and Opquisne, and after several repetitions on the ground consented to have the rope cut for fifty dollars. Dr. Jaune [Jones], the principal medical person in the city, attended in case of accident. The crowd was incredible, who shouted after the English fashion when they saw

Wilcox rise crowded in the cage, surrounded by forty-seven balloons fastened to it, with astonishing coolness, nodding his head to express his satisfaction and composure. After all, he could not rise above ninety-seven feet, according to the measures taken by two other gentlemen of the Philosophical Academy. He was at least five minutes in the air, but, perceiving the wind to blow from the east and drive him toward the Scoulquille [Schuylkill], he was frightened, and, agreeably to his instructions, made several incisions with a knife in three of the balloons. This was not sufficient, though we saw him descend a little. He pierced three more, and, seeing the machine did not come, his fear increased. He cut five more in the greatest haste, and, unfortunately, all on the same side. He was then seen to tack about (*chavirer*), and, as if he had slid down (*coulé bas*), he fell on the edge of a ditch and a finse [fence], as they call the inclosures. Dr. Jaune ran up; the poor man had sprained his wrist, but received no other accident."

No sooner was the fact demonstrated that men could safely rise into the air at will, than inventors began to devise plans for directing aërial machines. So long as the balloon is completely at the mercy of the wind, it is practically useless as a means of conveyance. On rising high above the ground the direction of aërial currents is often found to differ greatly from that of the surface-currents. Rising above the clouds, the aëronaut may lose sight of the earth and be carried at a rate of which he is totally unconscious, there being no means of measuring his speed when borne along with a current to which the balloon opposes no sensible resistance. By noting the times and places of ascent and descent, the rate has been estimated to exceed that of our fastest railroad-trains; and more than one aëronaut has lost his life by being carried out to sea. In the early part of 1784 M. Robert, the colleague of Charles, attempted the propulsion of a balloon by means of oars, but in vain. He subsequently tried artificial wings, but with no better success. M. Blanchard, who crossed the English Channel in 1785 with Dr. Jeffries, tried a variety of similar devices without success.

For the directing of balloons one of the first suggestions based on correct principles was offered by Francis Hopkinson. In a letter to Franklin, dated at Philadelphia, May 24, 1784, he recommends that the balloon shall be made oblong instead of spherical, and provided with a large and light wheel at the stern. "This wheel should consist of many vanes or fans of canvas, whose planes should be considerably inclined with respect to the plane of its motion, exactly like the wheel of a smoke-jack. If the navigator turns this wheel swiftly round by means of a winch, there is no doubt but it would (in a calm at least) give the machine a progressive motion, upon the same principle that a boat is *sculled* through the water." (Sparks's "Life and Works of Benjamin Franklin," vol. x, p. 93.) This remarkable suggestion by Hop-

kinson shows that he had quite definite views about the application of the principle of the screw-propeller to the direction of aërostatic machines, though in his day screw-propellers had not yet been applied even to surface navigation.

Hopkinson's suggestion did not then find its way into print. Even had it been published, the means were wanting for any experiments on a large scale. It would have been a noteworthy step in the right direction, but the muscular power of his imaginary aëronaut would have been far from sufficient to control the propeller. Nearly seventy years elapsed before his idea, independently evolved by another, was put to the test; and during this interval ballooning was but rarely applied to any other purpose than that of public display. The fruitless attempts to direct balloons were often made the subject of caricature.

In 1852 a young French engineer, who subsequently won the highest distinction, M. Giffard, constructed an elongated balloon (Fig. 1),

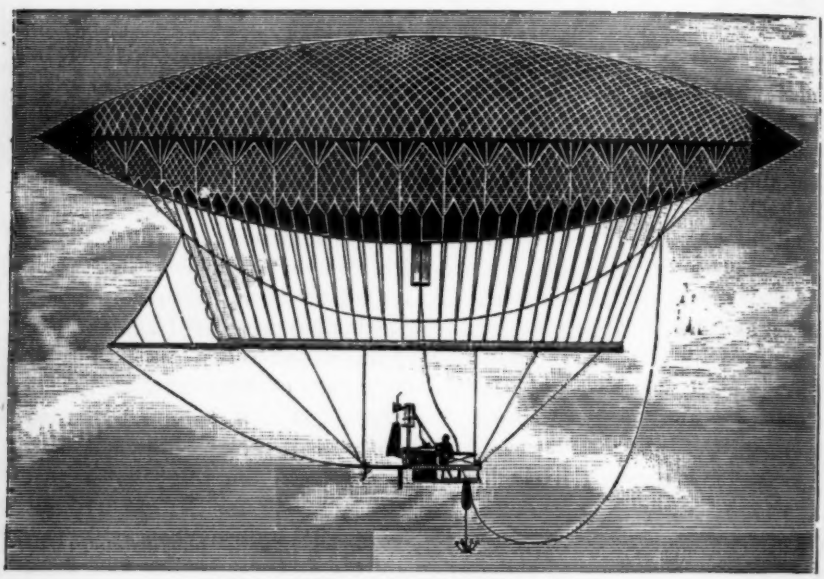


FIG. 1.—GIFFARD'S AËRIAL STEAMER, 1852.

pointed at both ends and filled with illuminating gas. Suspended beneath it by cords was a longitudinal shaft, at the end of which was a triangular sail that could be turned about an almost vertical axis and be made to serve the purpose of a rudder. About twenty feet beneath the shaft was hung a framework of wood, on which rested a small steam-engine, whose piston gave motion to a screw-propeller. The weight of the machine, including furnace, boiler, coal, and water, was not quite fourteen hundred pounds. On the 24th of September Giffard ascended with it over Paris to the height of five thousand feet. The wind was quite strong; but he was able to make very perceptible head-

way against this, and by the aid of the rudder to turn the machine into any desired direction. He thus proved incontestably that the problem of directing an aërial steamer was by no means insoluble. A second ascent was accomplished by him in 1855, but under unfavorable conditions. He made no further attempts with this machine, the abandonment of these experiments being due chiefly to their danger. A steam-engine, sending forth sparks beneath a mass of thirty thousand cubic feet of inflammable gas contained within an envelope of thin cloth, is a source of peril to which few men would be willing to expose themselves, even if lofty elevations were not reached. Trouble also resulted from the fact that the weight of the balloon could not be kept constant. The loss of the products of combustion and of spent steam made it difficult to preserve the proper relation between the ascensive power and the weight to be sustained.

Not quite twenty years after Giffard's experiments the problem was again attacked by M. Dupuy de Lôme. His immense balloon, containing one hundred and twenty thousand cubic feet of pure hydrogen, was nearly similar in shape to that of Giffard. The car beneath was capable of carrying easily fourteen men, seven of whom at a time were employed in working a capstan which controlled the shaft of the propeller, each of the two blades of this being about ten feet in length. On February 2, 1872, Dupuy de Lôme ascended in this balloon, and attained a speed estimated at 2·8 metres per second, equivalent to about six miles per hour. By means of the rudder he changed the direction through an angle of 12°. Giffard had attained an estimated speed of four metres per second, or nine miles per hour. Muscular power was thus shown to be far too uneconomical, while steam was too dangerous, to be employed in the direction of aërostats.

It was not until 1881, the year of Giffard's death, that electricity was applied as a motive power in the attempt to solve the difficult problem with which he had grappled. His pupil, M. Gaston Tissandier,* had early imbibed a passion for aëronautics, and made many successful ascents with spherical balloons. It was Tissandier who, in company with two friends, ascended in April, 1875, to the height of eight thousand six hundred metres, each of the three swooning on account of the rarefaction of the air, even before this limit was attained. The same aëronaut, in company with Fonvielle, was borne by the wind, in February, 1869, in thirty-five minutes, from Paris to Neuilly-Saint-Front, a distance of fifty miles. Keeping abreast with the progress of electrial science, Tissandier conceived the idea of employing storage-batteries instead of steam or hand power, as the immediate source of energy to actuate the propeller of an elongated balloon. He constructed a small experimental balloon, which was filled with hydrogen,

* The writer takes pleasure in acknowledging his personal indebtedness to M. Tissandier for the full accounts from which the facts set forth in the latter part of this article were obtained.

the effective ascensional force being two kilogrammes. A motor, of the Siemens type (Fig. 2), weighing only two hundred and twenty grammes, was made to turn the propeller, which consisted of a pair of vanes, each ten centimetres long; storage-cell, motor, and propeller being supported on a light platform suspended by netting. This

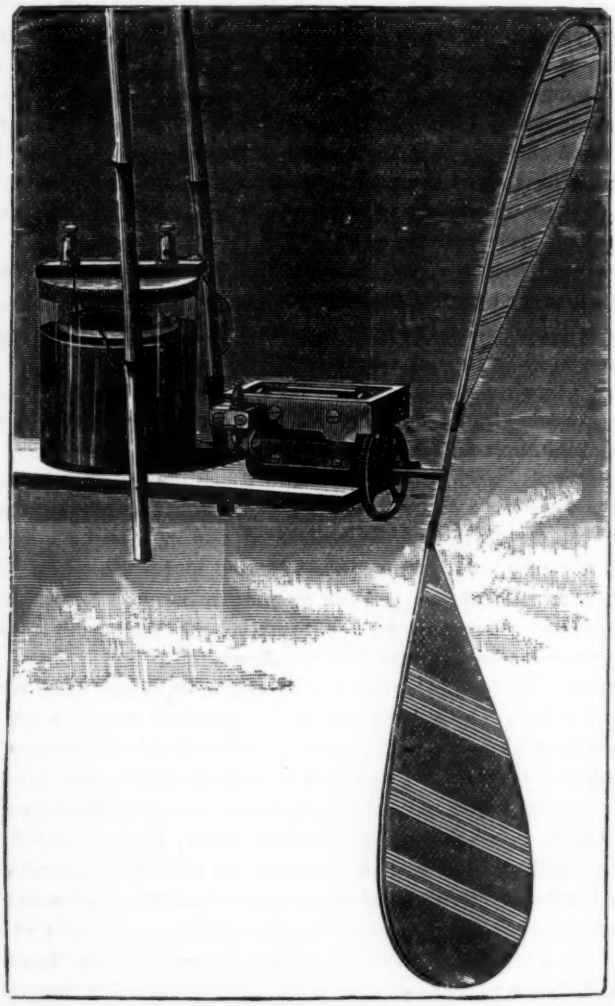


FIG. 2.—TISSANDIER'S MINIATURE ELECTRIC MOTOR AND PROPELLER, 1881.

"dirigeable" aërostat was exhibited at the Electrical Exposition of 1881, and a bronze medal awarded to the inventor. It attained a speed of about three metres per second.

Encouraged by this success, Tissandier undertook the work of constructing an aërostat large enough to lift two or three persons in addition to the weight of the propelling apparatus and other accessories.

The task was one which involved a heavy expenditure of money, aside from the time, labor, and thought bestowed by the inventor. He sought in vain to organize a company with a capital of two hundred thousand francs for the purpose of constructing an aërostat of three thousand cubic metres capacity; but the plan was not sufficiently promising of large dividends to be attractive to investors. No fortunes have been made thus far by the navigation of the air, and capitalists have not generally manifested a self-sacrificing spirit in behalf of pure science. The persevering aëronaut could find no one but his brother, M. Albert Tissandier, who was confident enough to join him in laying out capital for the promotion of what was generally regarded as a visionary scheme. The two brothers henceforward worked together, the one continuing to devote himself to the perfection of the electrical appliances on which reliance was to be placed, while the other, who is by profession an architect, gave his attention to the mechanical construction of the aërostat. M. Gaston Tissandier had found by experiments with his small aërostat that better results were to be had from a battery of cells, arranged in series, where a strong acid solution of potassium bichromate was the exciting liquid, than from a storage-battery—the energy evolved during the first few hours being greater in proportion to the weight of the battery. He originated several ingenious contrivances by which great lightness was secured, and the liquid could be conveniently brought into contact with the zinc and carbon plates, or removed at will without disturbing the plates.

A Siemens electric motor was constructed, weighing but fifty-five kilogrammes. When excited by the current from a battery of twenty-four elements weighing one hundred and sixty-eight kilogrammes, this motor was found capable of doing work equivalent to that of twelve or fifteen men, that is, from seventy-five to one hundred kilogramme-metres per second, continued through three hours, the weight of battery and motor together being but little in excess of the weight of three men. Tissandier devised also important improvements in the method of generating pure hydrogen rapidly on a large scale. The ascensive force of this gas when pure is about seventy-five pounds per thousand cubic feet, or eleven hundred and eighty grammes per cubic metre; while that of coal-gas which has been most generally employed for ballooning purposes is not more than five eighths as much. By the substitution of hydrogen, the size, and consequently the expense, of the balloon is correspondingly diminished.

The aërostat constructed by M. Albert Tissandier is shown in Fig. 3. It is ninety-two feet long, thirty feet in its greatest diameter, with capacity of about thirty-eight thousand cubic feet, and ascensive power of twenty-eight hundred pounds. The propeller, nine feet in diameter, is in the rear of the cage. Above it, and farther back, is a triangular sail, to be manipulated as a rudder. On October 8, 1883, the first ascent was made. The air at the ground was calm, but

on reaching a height of sixteen hundred feet the wind was blowing at the rate of rather more than six miles an hour. On putting the propeller into action, with a velocity of three revolutions per second, and turning the head of the aërostat against the breeze, it was kept motionless for some minutes; but the rudder soon proved to be insufficient to keep the direction constant, flapping like a sail, and at times

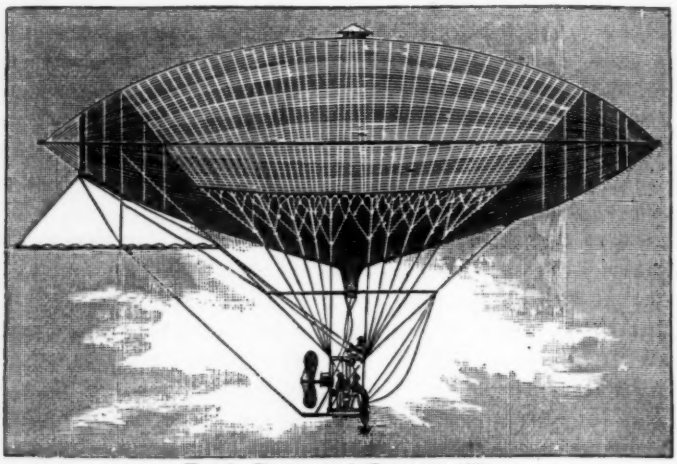


FIG. 3.—TISSANDIER'S BALLOON, 1883.

leaving the aëronauts at the mercy of the wind. After stopping the propeller and waiting until the direction of the aërostat coincided with that of the wind, the action was renewed. A marked acceleration in speed was the immediate result, and deviations from the line of the wind were secured by very slight motion of the rudder, the aërostat keeping its stability perfectly. The descent was safely accomplished after remaining in the air a little more than an hour.

This first experiment in the use of electricity in practical aëronautics was about as successful as that of Giffard with steam in 1852, so far as relates to the attainment of speed; but it showed that such speed could now be secured without danger and without any uncontrollable variation in the weight of the mass propelled. Tissandier did not expect the attainment of complete success in a single trial; such as he did attain was enough to convince not only him but others that he had opened out a pathway which could be followed with entire confidence. He had not the means at hand sufficient to enable him to keep his aërostat inflated, so as to repeat his experiment on the first favorable day after imposing such modifications as were suggested by the experience of the first ascent. It was not until September 26, 1884, that this opportunity was presented. The velocity of the wind was about the same as during the first ascent, but the aërostat was propelled at a rate about one third greater, so as to make at times very perceptible headway against the wind.

Meanwhile the success achieved by the Tissandier brothers in 1881 and 1883 had inspired MM. Renard and Krebs, officers of the French army, who were stationed at Chalais-Meudon, near Paris. They had for several years been conducting experiments on the conditions requisite for directing balloons, being guided in their studies by the previous work of Dupuy de Lôme. An appropriation of one hundred thousand francs had been granted them, during Gambetta's brief administration, and their investigations were conducted with the utmost secrecy. The pecuniary resources at their command gave them a great advantage over Tissandier, in the ability to construct a balloon much larger than that with which Tissandier's success had been achieved; and this permitted the application of a motor nearly seven times as powerful as the one previously employed. Their balloon (Fig. 4) is one hundred and sixty-six feet long, twenty-eight feet in greatest diameter, its capacity sixty-seven thousand cubic feet, and ascensional power nearly five thousand pounds. The ratio of length to thickness is thus much greater than in Tissandier's balloon. The details of construction of the battery and motor have not been given to the public by Captain Renard. The rudder is almost a parallelogram in form, and thickest in the middle, the cloth being tightly stretched over a light framework so as to present a rigid surface to the air. The propeller is fixed to the extremity of a long shaft, and placed at the front, instead of rear, of the balloon. The front end of the machine is thicker than the rear end. This feature seems rather unaccountable. The balloon is filled with hydrogen, but within it is a subsidiary balloon, connected by a tube with the cage, where air can be pumped in or out at pleasure, thus varying slightly the specific gravity of the mass as a whole and enabling the aëronauts to vary their elevation at will.

On August 9, 1884, an ascent was accomplished with this balloon, the atmosphere being almost perfectly calm. A journey of nearly two miles was made in a southerly direction, then over a mile westward, after which the balloon was turned northward and eastward. Very slight motion of the rudder was needed to execute these curves. Twenty-three minutes after their flight was begun the aëronauts were immediately over their starting-point, having made a trip of not quite five miles. In descending it was necessary to move backward and forward several times in succession, alternately reversing the direction of rotation of the propeller. The return to the ground was at the very spot from which the departure had been made. This remarkable feat was thus accomplished almost exactly one hundred and one years after the ascent of the first hydrogen balloon, sent up by Charles from a point but a few miles distant.

A second ascent was made by Renard and Krebs on the 12th of September, but with only partial success, in consequence of an accident to the motor. On the 8th of November two successive journeys

were taken, the balloon returning each time to its point of departure, and attaining a speed of nearly fifteen miles an hour, independently of the wind, which was blowing at the rate of five miles an hour.

In their communication to the French Academy of Sciences, on the 18th of August, Renard and Krebs accord to Tissandier the credit of

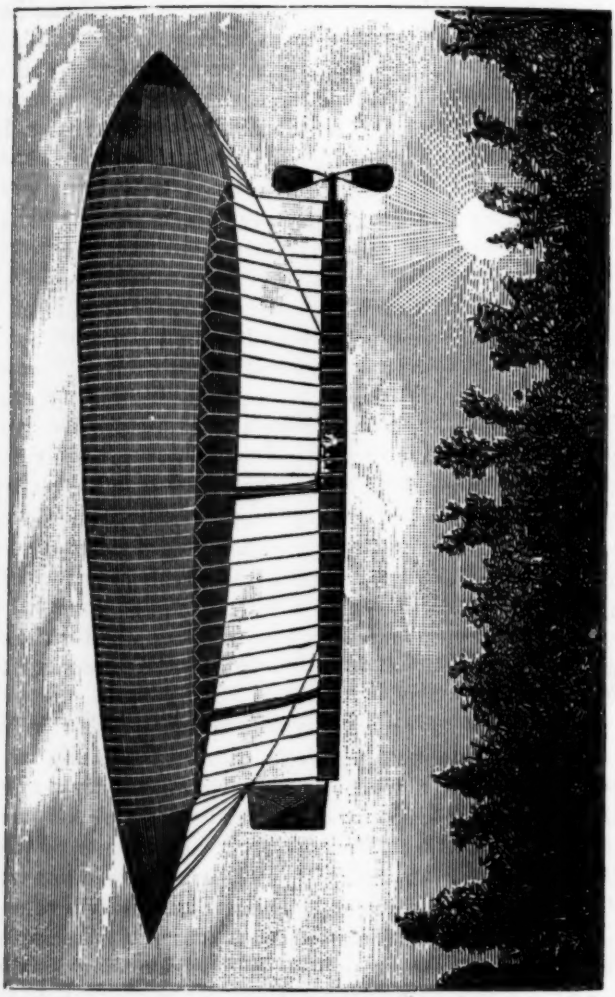


FIG. 4.—RENARD AND KREBS'S BALLOON, 1884.

priority in successfully applying electricity to the propulsion of balloons. Tissandier, on the other hand, equally freely accords to them the credit of making a pronounced success of what had been developed to only a limited extent in his hands on account of the want of funds. To each of the group the world must now give praise for the solution of a problem which was theoretically solved long ago, but involved practical difficulties that seemed almost if not quite insurmountable.

At best, however, the balloon as a means of locomotion is of more interest from a scientific than commercial standpoint. Increasing experience will determine the best disposition to be made in relation to a variety of points that are still open to discussion, such as the best methods of reducing resistances and increasing the efficiency of the motor. On the basis of the success already attained, calculations have been made which indicate that it may be quite possible in the near future to construct larger balloons that will travel in calm air at the rate of twenty-five or thirty miles an hour. Such air-ships, capable of ready direction at safe elevations, may serve important purposes in time of war. But for the public their use must long continue to be very limited. The enormous expense attendant upon the construction and manipulation of an aërostat capable of carrying even so few as a score of persons forbids competition with railroads and steamships. The high-tension battery, which is at present the most available source of energy to give motive power, has an effective life of only a few hours; and, even during this time, the cost of zinc and acid is far in excess of that of coal and water. For special purposes, where surface-locomotion is impossible, and expenses can be sustained by great corporations or very wealthy individuals, the "dirigeable" balloon may, perhaps, win for itself an important place. The history of the application of science to art, especially during the last half-century, suggests caution in making sweeping denials, merely because our present knowledge does not enable us to grasp all the details of future development. Dr. Lardner's assertion, that no steamship would ever cross the Atlantic, may well remain fresh in our minds. The present competition between electricity and coal-gas as illuminating agents could scarcely have been foreseen in the days when coal-gas was itself comparatively a novelty. If we continue, as is probable, to attain cheaper methods of generating electricity, the balloon may grow in favor as the electric light has done, but without causing the least commotion in the market for railroad stocks.

But, for the development of aëronautics as an art, we must continue to look to France, its earliest home. If stock companies are formed for the manufacture of air-ships, it must be first among those to whom the recent successes have already become a source of pride. Even as toys and as advertising media, balloons have always been more popular in France than elsewhere. The city of Paris has for years past included one or more large establishments devoted exclusively to the manufacture of them. Should "dirigeable" balloons ever become of commercial importance, enterprising Americans will be quick to imitate their French neighbors, and put upon our market all that the public may demand. The day is perhaps not far distant when at least a favored few in our own country may enjoy the luxury of summer afternoon excursions through the air, free from dust and cinders, and occasionally even vying with the birds in speed.

ARCHÆOLOGICAL FRAUDS.

By CHARLES C. ABBOTT, M. D.

IT seems rather hard lines that, even if the archæologist goes personally into the field, and gathers with his own hands specimens of stone implements, he is not quite free from the possibility of being imposed upon.

The cause of this unhappy state of affairs is found in several facts, all of which are of such character that it is well-nigh impossible to avoid being misled by them. In the first place, it requires much less skill and practice than is imagined to artistically shape arrow-heads and other small objects, from fragments of jasper and other minerals having a conchoidal fracture. Many boys, too impatient to gather the relics of the Indians, which requires considerable labor, often practice on broken specimens until they can repoint them, and convert others into handsome examples of scrapers, trimmed flakes, and other forms with which every archæologist is familiar. Unfortunately, the newly-fractured jasper presents a surface scarcely distinguishable from that of objects made centuries ago, so slowly does the process of weathering dull the surface of this flint-like mineral; and the eager collector, who a week before, it may be, charged the boys on various farms to keep all the relics they could find, receives, in his too great eagerness, as genuine, every specimen of known shapes, and is in no wise deceived in the difference in chipping between the ancient and the modern. Indeed, I greatly doubt if any difference can be detected in such simple forms as triangular arrow-heads, scrapers, trimmed flakes, and knives. I have time and again been shown handsome specimens, which I was assured were made by the exhibitors, and, on expressing some doubt, have had other specimens made in my presence. The skill with which one urchin chipped the characteristic beveled edge of a scraper, using only a small quartz pebble as a hammer or chipper, was marvelous, and I have good reason to believe I have been victimized more than once by this same youngster. Still, the prices usually paid for arrow-heads are not such as to warrant boys generally in undertaking the necessary preliminary practice of chipping flint, and the number of modern chipped implements is relatively not large; and being, in all cases, imitations of known patterns, they can not mislead. I do not think any of the Flint Jacks whom I have met ever attempted to design new forms, or copy those found in distant localities, a knowledge of which could only be derived from books. If such should become the case, dire confusion must inevitably arise.

In the case of such implements of stone as were made by pecking away the surface, and subsequently polishing all or portions of the surface, but few attempts to counterfeit have come to my notice. This

remark, however, is exclusive of all objects of hematite. So many hundreds of these are manufactured in Cincinnati and other cities, that no object of this material should be admitted into a museum or private cabinet unless its history rendered fraud absolutely impossible. Attempts at making grooved axes have been brought to my notice, but they were so rudely shaped, and so new in appearance, that deception was impossible. The flat pebbles, with two or four notches, known as "net-sinkers," are readily made, but are so abundant that to manufacture them, instead of looking for those made by the Indians, has not yet become profitable.

The Indians were quick to perceive how readily thin, flat sandstone pebbles could be perforated, and so become available as ornaments. Such objects I have gathered by the score from graves and village sites; and, as a result of calling the attention of collectors to these perforated disks, I find that they are now made in large numbers; being perforated with flint drills, and the "new" surfaces carefully polished with leather and emory. This gives the appearance of age, and such specimens are readily palmed off upon the unwary. Indeed, detection of the fraud is well-nigh impracticable. A rainy Saturday means mischief, so far as country school-boys are concerned; for I find that they often congregate in some quiet corner to drill pebbles and repoint arrow-heads; and then, lying in wait for the professor or the "'Gasy (Agassiz) Club" boys, from town, unload upon them the remarkable "finds" (?) made since their last vist. I do not wish to discourage archæological research, but simply to warn enthusiastic students against dangers to which they are exposed; for I speak from sad experience.

Of frauds in mound pottery and striped slate, I need not here make other mention than to caution the purchaser of specimens; for there are abundant counterfeits offered by dealers in curiosities. I do not mean to imply that these dealers are acquainted with the true history of the objects exposed for sale, for they, like the archæologists, are frequently imposed upon.

Unexaggerated as are the dangers of imposition such as I have pointed out, they are really insignificant as compared with that attaching to the purchase of steatite implements. It is well known that the Indians made constant use of this mineral for the manufacture of cooking-vessels, for smoking-pipes, and, to a limited extent, for small ornaments; but probably never for weapons. As the mineral is so readily worked, the cunning Flint Jacks have long been in the nefarious business of imitating pots, pipes, and trinkets, without number.

Philadelphia has the honor (?) of being the headquarters of steatite frauds; and it is not long since that one hundred beautiful objects, made by one man, were added to an extensive collection, at a cost of five hundred dollars. Had not the discovery of their origin been made in time, it would have resulted in American archæologists credit-

ing the Delaware Indians with far more skill in carving, even steatite, than they ever possessed. As tobacco-pipes have ever been the rarest and most costly of Indian relics, special attention was given to their manufacture, and very remarkable have been some of the specimens which have found their way into private cabinets and public museums. The history of some of these pipes is as intricate and fascinating as a novel, but want of space forbids its publication in this connection. Suffice it to say that the archæologist is only safe when he exhumes, in person, steatite pipes from graves, and finds other objects, either under like circumstances, or sees them plowed up on ancient village sites.

So determined, indeed, are some of these fabricators of frauds, that the following incident is worthy of being published, to show the ingenuity they exercise in their peculiar calling. To discover an Indian grave is, of course, a red-letter day for the archæologist. Now, *Indian graves are manufactured to order*, it would appear. At least the following recently occurred in New Jersey: A Philadelphia Flint Jack secured a half-decayed skeleton from a Potter's field in the vicinity, and placed it in a shallow excavation on the wasting bank of a creek in New Jersey, where Indian relics were frequently found. With it he placed a steatite tobacco-pipe of his own make, a steatite carving of an eagle's head, and beads; with these were thrown numbers of genuine arrow-heads and fragments of pottery. The earth was blackened with powdered charcoal. This "plant" was made in November, and, in the following March, during the prevalence of high waters and local freshets, he announced to an enthusiastic collector that he knew the location of an Indian grave, and offered to take him thither for fifty dollars, the money to be paid if the search proved successful, which of course it did. The cranium of that Philadelphia pauper passed through several craniologists' hands, and was gravely remarked upon as of unusual interest, as it was *a marked dolichocephalic skull, whereas the Delaware Indians were brachycephalic!*

A word, in conclusion, with reference to that much-vexed question, the contemporaneity of man and the mastodon in North America. Constantly objects are being brought to the attention of archæologists as having some bearing upon this question. As to whether the "elephant-pipes," of Iowa, or the "Lenapé-stone," of Pennsylvania, be genuine or not, no opinion is here expressed; but it is unquestionable that many of the remains of the mastodon found in New Jersey and New York are far more recent than some of the relics of man, and it is simply impossible that even so late a comer as the Indian should not have seen living mastodons on the Atlantic seaboard of this continent. Elephant-pipes and carvings should not be condemned, merely because of an impression still prevalent that the mastodon was a creature of an earlier geological epoch than the recent. This is but half the truth: he also shared the forests of the present with the fauna of historic times.

RAILROADS, TELEGRAPHS, AND CIVILIZATION.

By Herr C. HERZOG.

THERE has hardly been a more quiet decade in the political history of the nineteenth century than the one between 1830 and 1840. Yet that decade was the cradle of a new epoch, in which inventions first came into view, or were brought to practical completion, which have had a deeper and more permanent influence than any political event could have upon the shaping of human society. The first steam-railroad in Europe was built in the beginning of this decade, after George Stephenson had solved the problem of the locomotive in 1829. In 1833 Gauss and Weber fixed the first telegraph-wire between the Observatory and the Physical Cabinet in Göttingen, and thereby laid the foundation of electro-magnetic telegraphy, building on which Morse in 1836 invented the writing-telegraph. In this year, 1836, also, the first screw-steamer was built in England, and the transatlantic steam-traffic was opened two years later, or in 1838.

Only a few sharp and enlightened minds could have been able at that time to form a conception of the effects which these discoveries were destined to exercise upon the world; but their development from those feeble beginnings to the present day has immeasurably surpassed the most sanguine expectations.

The length of the railways, of which three hundred and thirty-two kilometres were in operation in 1830, had risen in 1883 to more than 444,000 kilometres; and, if the lines were joined one to another, they would have gone around the earth in its longest circumference more than ten times! Like a net, the meshes of which are continually drawing closer together, their lines are woven over all the countries of Europe; in both Americas, they have made way into the hitherto pathless wilderness; they have climbed the Rocky Mountains of the North and the Cordilleras of Peru, and have broken through the nation-dividing walls of the Alps; the largest streams of the earth wear the yoke of their bridges; in Southern Africa, in the East Indies, and in Japan, they are pressing unintermittingly into new regions, and even in the Chinese Empire trial-surveys are making for advantageous routes.

Steamship navigation has grown on a similarly grand scale. Nearly ten thousand steamers, with a capacity of seven million tons, traverse the ocean, and connect all parts of the earth with one another. Independent of wind and tide, they maintain communications with a swiftness, security, and regularity rivaling those of the railways, whose complement they are in providing for the world's trade.

More rapidly and extensively than both of these has the telegraph taken possession of the world. The conductor which, in 1833, con-

nected the study-rooms of two German scholars, has in fifty years spread out into a network of wires that incloses the earth. The length of the telegraph lines is estimated now at nearly a million kilometres, and the length of the wires at more than double that number. They stop for no obstacles, but find their way over mountains covered with eternal snow, through deserts, and across rivers. Even the sea does not stop them. More than seven hundred submarine cables bear messages over the bottom of the ocean with a speed outstripping that of the thought in which they originated. Hard as it was fifty years ago even approximately to imagine the impending development of the young discoveries and their influence, it is just as hard now to comprehend them in their fullness. The majority of living people take them for granted, and have no further thought about them. Railroads and telegraphs have been so much a matter of course to them from their childhood up that they can hardly conceive that it was ever different. But he whose memory goes back more than a generation, or whoever has traveled in countries where mules or oxen are the only means of transportation, can realize the difference and appreciate the importance of the progress, and the relations that exist between numerous phenomena of life and those concerns.

The most important and evident of these phenomena are the changes which railroads and telegraphs as means of trade have directly impressed on economical affairs; their influences have also made themselves felt, partly as consequences of those changes, in part directly, in transformations of social conditions, and of manners and customs.

It is common to the means of transportation moved by steam and to the telegraph that they effect changes of place, the former of physical objects and men, and the latter of thoughts, with power, speed, and security, immeasurably surpassing those of the formerly known means.

We will first consider the exchange of goods which composes trade. In his latest "Review of the World's Economy," Dr. Van Neumann-Spallart estimates the weight of the goods which the railroads collectively carried in 1882 at about 1,200,000,000 tons; the freight of the steamers was calculated at about half that weight. By far the greater part of these masses of goods have been set in motion by trade in order to place them where they could be made of use. For this reason, the figure of the weight, although the contemplation of it overtaxes our limited powers of conception, gives quite as little idea of the meaning of this enormous movement as does the knowledge of the weight of the blood circulating in the body, with which it is customary to compare this trade, an explanation of the effect of its flow.

The extension of trade may be considered as to space and as to

variety of articles. In the former respect, all parts of the earth have been drawn within the circle of exchanges, even those which formerly lay quite outside of such connections, either because they were thinly inhabited or too difficult of access; and the trade resources within civilized lands have been greatly expanded as the improvement of transportation facilities has compensated for the difference between the former cost and the present advance. The quantity of the goods used in trade and the variety are increased, or at least become available for whole classes of consumers, to whom their use was formerly forbidden on account of their price. Our daily life affords abundant examples of such articles. They are exemplified in the variety and prices of our food resources, in the fashions of our clothing, in our architecture, and in the warming and lighting of our houses. Coffee, tea, spices, and other products of the tropics, which were formerly rare among the wealthy, are now set upon the tables of the people, and are objects of general use. The European demand for wheat brings into competition steamers from Northern and Western America, Chili, the states of the La Plata, and India.

In clothing, the moderation of price resulting from the cheapened transportation of the raw materials and the wider distribution of the fabrics come more into view than the introduction of new or hitherto unknown or inaccessible materials, of which jute is the only example we now recollect. That silk, which was formerly a mark of wealth, is now worn by women of only moderate means, and cotton goods, which were articles of luxury a hundred years ago, are made into everybody's shirts and bedclothes, are in no small part due to the cheapness and speed of freight-carriage as well as to the increased facilities for manufacturing them afforded by the introduction of steam machinery.

The improvements which railroads and steamers have made possible in our buildings are also obvious, in the use of solid materials in regions far from the quarries. The coals with which we warm our houses and from which we derive our gas-lights, and the petroleum which burns in the lamps of the man of small means, articles which have become indispensable in modern life, but the use of which was formerly forbidden in all but the narrow regions of their productions, are now carried into the most remote mountain-valleys and across oceans, to wherever men live.

As railways and steamers perform the hard, steady, physical work of trade, so the telegraph assists the mental work of its service. Of the more than a hundred million telegrams which the electric wires carry over the earth yearly, by far the greatest part concern affairs of trade. The telegraph is the medium of all important communications in wholesale trade, and speculation could hardly exist without it. A commercial solidarity covering the whole globe has been built upon it, and the present generation for the first time sees a world-trade.

The connection is most evident in transactions in goods of large consumption, and is manifested in the tendency to equalization in prices and in the rates of discount. The price of the staple articles of commerce is fixed in the market of the world. The price of wheat is determined every day by the telegraphic reports to Chicago of the day's transactions in the principal places on the globe where wheat is handled, and the price of cotton in a similar manner at New Orleans and Liverpool; and in all financial transactions the most remote commercial centers respond to one another with a facility and celerity that can hardly be excelled by those with which two houses separated only by the Thames could communicate.

This extension of quick communication over the whole globe has been attended with the further advantages of making commercial products accessible to the largest possible circle of consumers, of making capital, which flows where it can be applied with the most profit, easily available at such spots, and in the acquisition of a number of storage-points whence goods can be dispatched with but little delay to the places where there is a demand for them. Conditioned upon these circumstances are the general decline of interest and the easier avoidance or quicker relief of the distress which may arise in single countries or districts from the temporary scarcity of some particular necessity. Railroads and steamboats have made the prevalence of real famine and the misery associated with it impossible so long as any purchasing power exists in a country or a city. Speculation, so much abused, while it looks out first for its own interests, takes care to compensate for local failures of crops by sending in timely supplies, and has in railroads and telegraphs ready and powerful instruments for its enterprise. That many men still actually suffer from hunger is not to be denied; but it nevertheless appears now to be impossible for the most of the world that a local scarcity of food arising from dearth or any disaster shall not be immediately remedied from without.

This wide community of interests also has its shadows. The ease with which large quantities of goods can be carried from countries where they have accumulated in excess under favoring conditions, to regions where this production is not equally favored, is fraught with disadvantages to the local producers by depreciating the prices of their goods when the circumstances are already hard for them. The depressing competition of American and Indian wheat in the European markets, which the home farmers lament with so much reason, is a striking example of this. Still more serious is the rapidity with which the effects of a commercial crisis occurring anywhere are felt in all markets. But these negative effects of solidarity of interests, hard as they may bear at times upon individuals, are insignificant as compared with the advantages it brings to the general welfare.

Apace with the widening of the trade in goods, has production

reached an unprecedented development, and this as regards quantity and variety and quality. If Industry knew what it was doing when in 1829 it offered a prize for a locomotive-engine available as a draught-power, its knowledge has brought it rich fruits. With that invention it gained a basis for increased production, and made it possible to bring together the raw material and the power at points where human skill and the other favorable conditions for production were found. The railroad carried coal and lime to the iron-mines, and cotton to the valleys where men's hands and valuable water-powers were waiting to be used; blast-furnaces and forges rose here, spinning and weaving establishments there. Industry was released from its bondage to the few spots where all the conditions favorable to its development existed together: and became mobile. It was enough after that if any one of those conditions was given in any place; what was wanting could be supplied at relatively small expense by means of the railway. Thus have great industries developed themselves mainly under the operation of these agencies. The remarkable phenomena in the economical field connected with these enterprises are the division of labor and the tendency to the equalization of wages, both as between different places and as against fluctuations in the prices of goods; the former prominently exemplified in the confinement of particular enterprises to special branches of production; the latter favored by the easy migration of laborers from place to place, and the rapid spread of news of advances in wages, as well as by the possibility of coalitions against uneven scales.

Just as a community of interest has been produced in the world's trade by the operation of railroads and telegraphs, so it has been in industries. Every advance in technics shortly becomes known and common, while those who are backward in taking it up suffer during the transition. On the other hand, local crises are felt by related industries far from the place of their origin, till, in fact, the distance becomes so great that the market is protected against the effects of the shock by the cost of transportation. But here, again, the flexibility and efficiency of the means of communication are of great help in overcoming such crises and equalizing their mischievous consequences.

The movement of persons has undergone quite as important a growth as that of goods. In the "Review of the World's Economy," already named, the number of passengers carried by all the railroads in all parts of the world, in 1882, is estimated at 2,400,000,000, or an average of six and half million a day. The absolute number of passengers carried on steamers is smaller; but here, as was also the case with goods, they are carried for longer distances, and more days' journeys, than on railroads; so that, estimated by the mile or the day, the amount both of freight and passenger work the steamers do will appear to much better advantage.

The significance of the facilitation of passenger transportation is

derived principally from its effects on social conditions, civilization, and customs. One of the most important of these effects is illustrated in emigration, which has assumed grand dimensions under the operation of the new methods of communication. Of the twelve and a half million emigrants who went to the United States between the recognition of their independence and 1883, not more than a million belong to the time previous to the establishment of regular passenger communication by steamer with Europe, about 1844. As a result of the establishment of this method of communication, and of the building of the railroads that opened the Mississippi Valley and the western part of the continent, emigration assumed colossal proportions. Besides the amelioration of the voyage, which has become an affair of not more than ten or twelve days for emigrant-vessels, the improved fare, the cheaper rate of passage, and the punctuality and increased safety of the transit, may be marked as circumstances contributing to this result.

The difficulties of the land-journey were formerly hardly less formidable to emigrants seeking the interior of the country than were those of the sea-voyage. Weeks and even months might be spent in reaching the end of the journey, while the traveler had to do without everything he could not take along with him, or else to procure it at the expense of great trouble and cost. Now the railroad carries one from the port of arrival, in as many days as months were formerly required, to the extreme West; and, finding himself there, he is no longer lost in the wilderness, with nothing but his own efforts to depend upon; but he has a railroad passing at no very great distance, to keep him in constant communication with civilization. To these great impulses may be added the increased facilities for coming and going within their own country. Formerly the poor man was tied to his threshold by the impossibility of obtaining the means to get away. Now, at an expense of time and money relatively trifling, he is able to go and seek other places where he may find better fields for the exercise of his powers and easier conditions of existence. In this way the condition of the poorer and the laboring classes has been immeasurably altered. Hence we see a streaming of working-men toward the centers of great industries, large towns growing up, labor become scarce in the agricultural districts, and the industrial organizations undergoing a revolution. The labor market has undergone the same kind of extension as the market for goods; and skilled labor has become more and more a thing of merchandise, the price of which is regulated by the larger conjunctures of business. The personal relation between laborer and employer, which formerly, at least in handicraft work, had somewhat the aspect of a family relation, has been dissolved or relaxed.

We have also to speak of the services which the post has rendered. They are by no means limited to the economical field, but they are

most evident there. Trade and industry, and all economical life, could hardly be thought of to-day without the co-operation of the post. And that it has surely, effectively, and abundantly contributed to their advancement, to a degree that appears wonderful to us, has again been made possible only by the use of railroads, steamers, and telegraphs. Neither the relatively small postage rate within a single state nor the moderate rate of the Postal Union, the establishment of which represented one of the most remarkable stages in the progress of civilization, would have been possible without these vehicles, as the always ready, cheap, and indefatigable bearers of our correspondence.

So dependent upon one another are all the factors of human life that we should expect to observe the effects of the agencies we have been considering upon all, and we do so observe them, most prominently, perhaps, besides the points on which we have remarked, upon the modern methods of war. The steamer has within the last thirty years taken the place of the sailing-vessel in the navies of all countries to such an extent that the latter is only exceptionally used for warlike purposes. Connected with this change are changes in the form and handling of the guns, armoring, the introduction of turret-ships, and modifications of naval tactics.

While the locomotive has not been made a direct arm, railroads and telegraphs have greatly changed the aspects of war on land. With their help, the mobilization of the army and the concentration of its scattered divisions at the point selected for attack or defense are accomplished in a space of time that is almost as nothing compared with what was required to move troops by the old method. The skillful and energetic use of these helps gives, under some circumstances, an impetus that may be decisive for the issue of the war. They are no less important during the progress of the war, in that they are useful for the forwarding of troops and camp-supplies. The army that controls the railroads is master of the field. It is for the general so to manage the movements of troops by their aid that his forces shall at any given time be superior to those of the enemy at an appointed place, and either compel them to retreat or to fight under unfavorable circumstances. Modern strategy, therefore, consists no little in having knowledge and skill enough to operate with the railroads as the most important factors of movements and the actions, in which, with modern arms, multitudes of men are of more effect than personal bravery, as never to strike except where and when he knows that his forces are superior. It is also an important consideration that provisions and ammunition and re-enforcements can be steadily supplied to the army by means of railroads, so as to keep it constantly effective, even in the enemy's country; and that the wounded can be carried away from the neighborhood of the battle-field to hospitals far back, or to their homes.

While it is true that wars have in these days become more bloody,

it can also be said that they are shorter and, in a certain sense, more humane; the latter, not only in the fact that the victims of battle receive better care, but also that the peaceful population of the country visited by war are, by means of the improved facilities for communication, spared the burden of maintaining the invading army. The greater part of the cruelty and barbarity of former wars arose from the fact that the troops had to be supported by the land in which they were encamped, and the necessity of their taking care of themselves excluded all consideration for the people. War is still a direful scourge; but the arrangements for provisioning and foraging and the system of requisitions which railroads have made possible place the military administration in a condition to spare the country from exhaustive drafts, and to prevent excesses by the soldiers. The influence of modern means of intercourse may also be seen in the peaceful relations of states to one another, and in the inner political life of individual states. We shall make no mistake if we assign to railroads and telegraphs an important part in the present tendency to form large states and to give greater consistency to national organizations. Similarity and community of economical interests are not consistent with separation by arbitrary divisions. Material interests require the widest possible conformity of legislation and administration and a strong civil power able to give them external and internal protection, neither of which can be afforded in the small state. Railroads and telegraphs are a political force of the first order to promote in nascent states the accomplishment of their union, in established states the strengthening of the executive and the growth of the political influence of the government. In all civilized states the telegraph and the railroads together enable the government to be advised of all important events on the instant of their happening, and immediately to take whatever measures may be necessary. It is a further consequence that the central power becomes more concentrated, and the individual prerogative and responsibility of the local officers limited; while in smaller states the administrative organization may be simplified by dispensing with intermediate agents.

The effect of railroads and telegraphs upon the civic structure is also manifested in the more lively participation of the people in political life. This happens both in consequence of the increased ease of personal intercourse and through the quickening and increased extent of the exchanges of thought that are furthered by the press and by correspondence. The freer intercourse of candidates with the people whose votes they are seeking, and of deputies with their constituents, has done much to make the people acquainted with public questions in their varying aspects, and interested in them. Much more is done by the periodical press, which now scatters its issues in numbers and with a speed and cheapness that would have been incredible a half-century ago. Other factors are indeed contributing to this condition, but they

would be practically of little value in producing these effects were they not accompanied by correspondingly increased facilities for the diffusion of news. It fails to give an adequate idea of the extent of this influence, to state that two and a half milliard copies of newspapers were circulated in 1882 through the Postal Union, and that only an insignificant proportion of these were carried otherwise than by railroad. Most of these journals being political, the part they have in diffusing political intelligence among the people, who depend almost entirely upon them, and in forming their political culture, may be conceived but can not be measured.

This feature also is attended with disadvantages. The newspapers circulating in all classes of society, the number of persons upon whom the formation of that vague force called public opinion depends has become multiplied many times, and in it many are included who have not the previous knowledge requisite to the formation of an intelligent opinion, or capacity to form a real opinion of their own. Consequently, the quality of public opinion has depreciated. It is more easily led into error, and harder to set right. Furthermore, the rapidity with which the telegraph makes it possible to convey news of all important events—and unimportant ones, too—from all parts of the world to all other parts, has given public opinion a taste and a preference for mere matters of fact. The pressure to learn the latest news is stronger than the desire to know events in their order and connections. Thus interest is rather directed to what is striking and sensational, and, responding to this, the papers give to news of that kind space and conspicuousness out of all proportion to its value. Consequently, we have shallowness of public opinion on the one side, exaggeration and unreliability on the other.

In another aspect, railroads and telegraphs have contributed to the increase of knowledge and the expansion of the ideas and conceptions of the people ; indirectly by assisting in the circulation of journals that carry knowledge on all kinds of subjects through all the channels of their circulation, and directly by making it possible for people of moderate means, and inducing them, to travel and observe for themselves things and phenomena abroad. When I was a boy, the journey of about thirty miles to the capital of the province was an event for children and parents, which was talked about and prepared for for weeks beforehand, and required a whole day of traveling. People seldom went beyond the boundaries of the province, except on business, or on the occasion of important festivals, or of death. Now we can travel to the sea-coast or the mountains in the same time, and with hardly more expense than it then took to go the thirty miles, and we eagerly use the opportunity to change our scene, whether it be to improve the health a shade, for mental relaxation, for instruction, or for pleasure. The attendance at baths, the rise of summer resorts and air-cures, and furloughs for all classes of officers, have

become regular institutions, while they were formerly indulged only in cases of sickness; and the excursions of school vacations, the pleasure-trains and the extra trains on holidays, long wedding tours, excursion parties to foreign lands, or around the world, are evidences of the taste for traveling that modern men feel, and of the ease with which it is gratified. Then there are the journeys to meetings of men of a common calling, to scientific congresses or social unions. There is hardly a condition or a professional society that does not feel the need of bringing its members together, and of holding at different but always agreeable places social unions. To these we may add exhibitions, in which fisheries and agriculture, the industries and the fine arts display and compare their efforts, with their culmination in periodical world's fairs. Without railroads this mobility and this releasing of men from their soil, which answer a deep longing of our nature, would be possible only within the narrowest limits.

It can not be denied that with all this are connected a great enrichment, with new views and feelings, a considerable enlargement of mental scope, and a strong stimulus to mental activity, even where no intention of the kind is entertained. Errors are cleared up and prejudices are overcome. Deficiencies at home are revealed by comparison with what is seen abroad, and all that is recognized as better is imitated and improved upon. Habits are also disciplined. Railroads demand an exact account of time, and require all who use them to conform to their regulations. They train people in the most efficient manner to punctuality, to quick decision, and to the omission of formalities.

The forms of intercourse and family relations are also not slightly affected. It can hardly be said that the influence in the former case is always beneficial. Politeness and regard for fellow-travelers, if they happen to interfere with one's own comfort, are not exactly cultivated with zest by railroad-passengers. But we frequently meet polite and interesting traveling-companions, whose intercourse gives us pleasure. Moreover, railroad-traveling brings persons of different degrees of cultivation together, and is fitted to smooth the forms of intercourse, and to have, on the whole, a refining influence, provided cultivated persons set good examples.

I am uncertain whether heart-connections leading to marriage are often formed on railway-journeys. If we may trust the novelists and playwrights, this is the case. At any rate, railway-traveling has an influence on relations of this kind to the extent that it favors the forming of acquaintances between persons living at a distance from one another, out of which family relations may grow. Marriages certainly are negotiated over a much wider scope than formerly, both within the country of residence and as reaching into foreign countries. Distance offers no obstacle to the father's informing himself concerning the circumstances of his daughter's suitor; and the careful mother can con-

sent to let her child go to places which would formerly be considered out of the world, because she can correspond with her daily; and it only requires a journey of a few hours or days, which also promises a welcome variety to the monotonous life of the parental home, to bring the separated family together again. A change has also come over the course of family life, in which habit and tradition had established fixed customs, whereby the old ways are slowly dissolved and new forms take their place. The prescription of kin, in which the choice of a wife was formerly confined, is relaxed; the old Frankish courting by the parents for the son is out of fashion; the wedding-feast is arranged to suit the railroad-train on which the young couple will begin their journey; fresh blood and strange customs are pressing into the close circle of ancient relationship and stiff usage; they break up the pride of neighborhood narrowness, and make it first tolerant, then inviting to the foreign better usages, against which it had shut itself up, and which it had despised, merely because they were strange.

On the other side, if modern facilities for moving about furnish opportunities for extending our ideas and knowledge, they also lead to superficiality in observation, which loses in depth and thoroughness what it gains in extent. We travel far in a day, but we see only by glances. Between the beginning of the journey and its appointed end the passenger generally stops only as long as the train, or, at very important stations, only over till the next train. What lies between passes before his vision like a scene in a theatre, or is lost while he sleeps. The guide-books furnish all the information he seeks. For many the number of miles they have traveled over is the most important point. It is evident that nothing useful can come from traveling of this kind. Another undeniable result is the neglect of what is near and around us for what is distant. Many people know more of foreign countries than of their own neighborhoods, consequently their attachment for home is weakened. From indifference to disdain is only a step. On this ground are explained the disappearance of old customs, which gave fixedness to social life in the family and the commune, the dissatisfaction with the narrowness of the home, and a relaxation of regard for persons in authority and for older persons, whose experiences, gathered in the narrow home circle, are not allowed to compete with the assumed versatile and superior knowledge of traveled youth. In a wider circle are thus explained the rapid spread of the fashions and a kind of leveling in life and customs. The new styles, which formerly went out very slowly, now spread quickly through all classes, and the differences between country and city are disappearing.

Returning to the public life of society, we find two features in which there seems to be a connection between changes that are going on and the modern conditions of transportation, viz., the democratic tendencies of society, and the prevalence of materialism. The democratic tendency, which is peculiar to the times, does not limit itself to

exhibition in state constitutions, but is penetrating the whole social life. In its wider sense it signifies the mergence of class-differences, the abolition of transmitted privileges and inherited exclusiveness, and the assertion of individuality. It is true that this tendency is older than the railroads and telegraphs, and its origin can not be ascribed to them; but it is also true that they have given it a great impulse, to which compulsory education, universal military obligation, and universal suffrage, have equally contributed. Railroads treat all their passengers alike. All must adapt themselves to the same order and regulations. No one can interfere with the time of arrival or departure, or the speed, or the length of stoppages. Even special trains must not interfere with the time-table. In the case of cars of different classes, the only criterion of distinction is that of price; whoever pays the charge can travel in the corresponding class, whether it pleases his fellow-passengers or not, and he receives the same treatment as they. The ideas suggested by such commingling are very apt to be carried into other fields of intercourse.

With the democratizing of society is flowing a parallel current of a practical materialism, which is manifested in a predominance of material interests over ideal ones, in the recognition of egoism as a leading principle in trade, in the estimation of men's deeds, only according to their visible consequences, and in the rejection of all that transcends realism. This drift is not new in human civilization; but it is a new fact that the masses have been drawn into it, and that they aim to make it potent after they have destroyed or reformed the old civil and social order. Its causes are complicated, and are perhaps only indirectly referable to the expansion of means of communication; but they are connected with the results of increased traffic and intercourse, and their operation is re-enforced by them.

It is too soon to speculate as to what will be the end or the ultimate result of these two parallel movements.—*Translated for the Popular Science Monthly from the Deutsche Rundschau.*

DIET IN RELATION TO AGE AND ACTIVITY.

By Sir HENRY THOMPSON.

ENOUGH, and more than enough, perhaps, has been uttered concerning the prejudicial effects on the body of habitually using alcoholic beverages. It is rare now to find any one, well acquainted with human physiology, and capable of observing and appreciating the ordinary wants and usages of life around him, who does not believe that, with few exceptions, men and women are healthier and stronger, physically, intellectually, and morally, without such drinks

than with them. And confessedly there is little or nothing new to be said respecting a conclusion which has been so thoroughly investigated, discussed, and tested by experience, as this. It is useless, and indeed impolitic, in the well-intentioned effort to arouse public attention to the subject, to make exaggerated statements in relation thereto. But the important truth has still to be preached, repeated, and freshly illustrated, when possible, in every quarter of society, because a very natural bias to self-indulgence is always present to obscure's men views of those things which gratify it. While, in addition to this, an exceedingly clever commercial interest of enormous influence and proportions never ceases to vaunt its power to provide us with "the soundest," "purest," and most to be suspected of all with even "medically certified," forms of spirit, wine, and beer; apparently rendering alcoholic products conformable to the requirements of some physiological law supposed to demand their employment, and thus insinuating the semblance of a proof that they are generally valuable, or at least harmless, as an accompaniment of food at our daily meals.

It is not, however, with the evils of "drink" that I propose to deal here: they are thus alluded to because, in making a few observations on the kindred subject of food, I desire to commence with a remark on the comparison, so far as that is possible, between the deleterious effects on the body of erroneous views and practice in regard of drinking, and in regard of eating, respectively.

I have for some years past been compelled, by facts which are constantly coming before me, to accept the conclusion that more mischief in the form of actual disease, of impaired vigor, and of shortened life, accrues to civilized man, so far as I have observed in our own country and throughout Western and Central Europe, from erroneous habits in eating, than from the habitual use of alcoholic drink, considerable as I know the evil of that to be. I am not sure that a similar comparison might not be made between the respective influence of those agencies in regard of moral evil also; but I have no desire to indulge in speculative assertion, and suspect that an accurate conclusion on this subject may be beyond our reach at present.

It was the perception, during many years of opportunity to observe, of the extreme indifference manifested by the general public to any study of food, and want of acquaintance with its uses and value, together with a growing sense on my own part of the vast importance of diet to the healthy as well as to the sick, which led me in the year 1879 to write two articles in this review entitled "Food and Feeding." And since that date fresh experience has, I confess, still enhanced my estimate of the value of such knowledge, which indeed it is impossible to exaggerate, when regarding that one object of existence which I suppose all persons desire to attain, viz., an ample duration of time for enjoying the healthy exercise of bodily and mental function. Few would, I presume, consider length of life a boon apart

from the possession of fairly good health; but this latter being granted, the desire for a prolonged term of existence appears to be almost universal.

I have come to the conclusion that a proportion amounting at least to more than one half of the disease which imbitters the middle and latter part of life among the middle and upper classes of the population is due to avoidable errors in diet. Further, while such disease renders so much of life, for many, disappointing, unhappy, and profitless, a term of painful endurance, for not a few it shortens life considerably. It would not be a difficult task—and its results if displayed here would be striking—to adduce in support of these views a numerical statement showing causes which prematurely terminate life among the classes referred to in this country, based upon the Registrar-General's reports, or by consulting the records of life-assurance experience. I shall not avail myself of these materials in this place, although it would be right to do so in the columns of a medical journal. My object here is to call the attention of the public to certain facts about diet which are insufficiently known, and therefore inadequately appreciated. And I shall assume that ample warrant for the observations made here is within my reach, and can be made available if required.

At the outset of the few and brief remarks which the space at my disposal permits me to make, I shall intimate, speaking in general terms, that I have no sympathy with any dietary system which excludes the present generally recognized sources and varieties of food. It is possible, indeed, that we may yet add considerably to those we already possess, and with advantage; but there appears to be no reason for dispensing with anyone of them. When we consider how varied are the races of man, and how dissimilar are the climatic conditions which affect him, and how in each climate the occupations, the surrounding circumstances, and even the individual peculiarities of the inhabitants, largely differ, we shall be constrained to admit that any one of all the sources of food hitherto known may be made available, may in its turn become desirable, and even essential to life.

To an inhabitant of the Arctic Circle, for example, a vegetarian diet would be impracticable, because the elements of it can not be produced in that region; and, were it possible to supply him with them, life could not be supported thereby. Animal food in large quantity is necessary to sustain existence in the low temperature to which he is exposed. But I desire to oppose any scheme for circumscribing the food resources of the world, and any form of a statute of limitations to our diet, not merely because it can be proved inapplicable, as in the case of the Esquimaux, under certain local and circumscribed conditions, but because I hold that the principle of limiting mankind to the use of any one class of foods among many is in itself an erroneous one. Thus, for example, while sympathizing to a large

extent myself with the practice of what is called "vegetarianism" in diet, and knowing how valuable the exclusive or almost exclusive use of the products of the vegetable kingdom may be for a considerable number of the adult population of our own and of other countries in the temperate zones, and for most of that which inhabits the torrid zone, I object strongly to a dogmatic assertion that such limitation of their food is desirable for any class or body of persons whatever. Moreover, an exclusive or sectarian spirit always creeps in sooner or later, wherever an "ism" of any kind leads the way, which sooner or later brings in its train assertions barely supported by fact, the equivocal use of terms, evasion—in short, untruthfulness, unintended and unperceived by the well-meaning people who, having adopted the "ism," at last suffer quite unconsciously from obscurity of vision, and are in danger of becoming blind partisans.

Thus the term "vegetarian," as used to distinguish a peculiar diet, has no meaning whatever unless it implies that all the articles of food so comprised are to be products of the vegetable kingdom; admitting, of course, the very widest scope to that term. In that sense the vegetable kingdom may be held to embrace all the cereals, as wheat, barley, rye, and oats, maize, rice, and millet; all the leguminous plants—beans, peas, and lentils; all the roots and tubers containing chiefly starch, as the potato, yam, etc.; the plants yielding sago and arrowroot; the sources of sugar in the cane and beet, etc.; all the garden herbs and vegetables; the nuts, and all the fruits. Then there are the olive and other plants yielding the important element of oil in great abundance. An admirable assortment, to which a few minor articles belong, not necessary to be specified here. An excellent display of foods, which suffice to support life in certain favorable conditions, and which may be served in varied and appetizing forms. And to those who find their dietary within the limits of this list the name of vegetarian is rightly applicable. But such is by no means the practice of the self-styled vegetarians we usually meet with. It was only the other evening, in a crowded drawing-room, that a handsome, well-developed, and manifestly well-nourished girl—"a picture of health" and vigor—informed me with extreme satisfaction that she had been a "vegetarian" for several months, and how thoroughly that dietary system agreed with her. She added that she was recommending all her friends (how natural!) to be vegetarians also, continuing, "And do you not believe I am right?" On all grounds, one could only assure her that she had the appearance of admirably illustrating the theory of her daily life, whatever that might be, adding, "But now will you tell me what your diet consists of?" As happens in nineteen cases out of twenty, my young and blooming vegetarian replied that she took an egg and milk in quantity, besides butter, not only at breakfast, but again in the form of pudding, pastry, fritter, or cake, etc., to say nothing of cheese at each of the two subsequent meals of the day: animal food,

it is unnecessary to say, of a choice, and some of it in a concentrated form. To call a person thus fed a vegetarian is a palpable error; to proclaim one's self so almost requires a stronger term to denote the departure from accuracy involved. Yet so attractive to some, possessing a moral sense not too punctilious, is the small distinction attained by becoming sectarian, and partisans of a quasi-novel and somewhat questioned doctrine, that an equivocal position is accepted in order to retain if possible the term "vegetarian" as the ensign of a party, the members of which consume abundantly strong animal food, abjuring it only in its grosser forms of flesh and fish. And hence it happens, as I have lately learned, that milk, butter, eggs, and cheese are now designated in the language of "vegetarianism" by the term "animal *products*," an ingenious but evasive expedient to avoid the necessity for speaking of them as animal food!

Let us, for one moment only, regard milk, with which, on Nature's plan, we have all been fed for the first year, or thereabout, of our lives, and during which term we made a larger growth and a more important development than in any other year among the whole tale of the life which has passed, however long it may have been. How, in any sense, can that year of plenty and expansion, which we may have been happy and fortunate enough to owe—an inextinguishable debt—to maternal love and bounty, be said to be a year of "vegetarian diet"! Will any man henceforward dare thus to distinguish the source from which he drew his early life? Unhappily, indeed, for want of wisdom, the natural ration of some infants is occasionally supplemented at an early period by the addition of vegetable matter; but the practice is almost always undesirable, and is generally paid for by a sad and premature experience of indigestion to the helpless baby. Poor baby! who, unlike its progenitors in similar circumstances, while forced to pay the penalty, has not even had the satisfaction of enjoying a delightful but naughty dish beforehand.

The vegetarian restaurant at the Health Exhibition last summer supplied thousands of excellent and nutritious meals at a cheap rate, to the great advantage of its customers; but the practice of insisting with emphasis that a "vegetable diet" was supplied was wholly indefensible, since it contained eggs and milk, butter and cheese in great abundance.

It is not more than six months since I observed in a well-known weekly journal a list of some half-dozen receipts for dishes recommended on authority as specimens of vegetarian diet. All were savory combinations, and every one contained eggs, butter, milk, and cheese in considerable quantity, the vegetable elements being in comparatively small proportion!

It is incumbent on the supporters of this system of mixed diet to find a term which conveys the truth, that truth being that they abjure the use, as food, of all animal flesh. The words "vegetable" and

"vegetarian" have not the remotest claim to express that fact, while they have an express meaning of their own in daily use—namely, the obvious one of designating products of the vegetable kingdom. It may not be easy at once to construct a simple term which differentiates clearly from the true vegetarian the person who also uses various foods belonging to the animal kigndom, and who abjures only the flesh of animals. But it is high time that we should be spared the obscure language, or rather the inaccurate statement, to which milk and egg consumers are committed, in assuming a title which has for centuries belonged to that not inconsiderable body of persons whose habits of life confer the right to use it. And I feel sure that my friends "the vegetarians," living on a mixed diet, will see the necessity of seeking a more appropriate designation to distinguish them; if not, we must endeavor to invent one for them.

But why should we limit by dogma or otherwise man's liberty to select his food and drink? I appreciate the reason for abstaining from alcoholic drinks derived from benevolent motive or religious principle, and entertain for it the highest respect, although I can not myself claim the merit of self-denial or the credit of setting an example—abstaining, like many others, solely because experience has taught that to act otherwise is manifestly to do myself an injury.

This brings me to the point which I desire to establish, namely, that the great practical rule of life in regard of human diet will not be found in enforcing limitation of the sources of food which Nature has abundantly provided. On the contrary, that rule is fulfilled in the perfect development of the art of adapting food of any and every kind to the needs of the body according to the very varied circumstances of the individual, at different ages, with different forms of activity, with different inherent personal peculiarities, and with different environments. This may read at first sight, perhaps, like a truism; but how important is the doctrine, and how completely it is ignored in the experience of life by most people, it will be my object here to show.

I have already alluded to the fact that the young and rapidly growing infant, whose structures have to be formed on the soft and slender lines laid down before birth, whose organs have to be solidified and expanded at one and the same time, in which tissues of all kinds are formed with immense rapidity and activity, requires animal food ready prepared in the most soluble form for digestion and assimilation. Such a food is milk; and, if the human supply is insufficient, we obtain in its place that of the cow, chiefly; and during the first year of life milk constitutes the best form of food. After that time other kinds of nourishment, mostly well-cooked wheaten flour in various shapes, begin to be added to the milk which long continues to be a staple source of nourishment to the young animal. Eggs, a still more concentrated form of similar food, follow, and ultimately the dietary is enlarged by additions of various kinds, as the growing pro-

cess continues through youth to puberty, when liberty arrives more or less speedily to do in all such matters "as others do." On reaching manhood, the individual in ninety-nine cases out of a hundred acquires the prevailing habit of his associates, and he feeds after that uniform prescription of diet which prevails, with little disposition to question its suitability to himself. A young fellow in the fullness of health, and habituated to daily active life in the open air, may, under the stimulus of appetite and enjoyment in gratifying it, often largely exceed both in quantity and variety of food what is necessary to supply all the demands of his system, without paying a very exorbitant price for the indulgence. If the stomach is sensitive or not very powerful, it sometimes rejects an extravagant ration of food, either at once or soon after the surfeit has been committed; but, if the digestive force is considerable, the meals, habitually superabundant as they may be, are gradually absorbed, and the surplus fund of nutrient material unused is stored up in some form. When a certain amount has been thus disposed of, the capacity for storage varying greatly in different persons, an undesirable balance remains against the feeder, and in young people is mostly rectified by a "bilious attack," through the agency of which a few hours of vomiting and misery square the account. Then the same process of overfeeding recommences with renewed appetite and sensations of invigorated digestion, until in two or three, or five or six weeks, according to the ratio existing between the amount of food ingested and the habit of expending or eliminating it from the body, the recurring attack appears and again clears the system, and so on during several years of life. If the individual takes abundant exercise and expends much energy in the business of life, a large quantity of food can be properly disposed of. Such a person enjoys the pleasure of satisfying a healthy appetite, and doing so with ordinary prudence not only takes no harm, but consolidates the frame and enables it to resist those manifold unseen sources of evil which are prone to affect injuriously the feeble. On the other hand, if he is inactive, takes little exercise, spends most of his time in close air and in a warm temperature, shaping his diet nevertheless on the liberal scheme just described, the balance of unexpended nutriment soon tells more or less heavily against him, and must be thrown off in some form or another.

After the first half or so of life has passed away, instead of periodical sickness, the unemployed material may be relegated in the form of fat to be stored on the external surface of the body, or be packed among the internal organs, and thus he or she may become corpulent and heavy, if a facility for converting appropriate material into fat is consistent with the constitution of the individual; for some constitutions appear to be without the power of storing fat, however rich the diet or inactive their habits may be. When, therefore, this process can not take place, and in many instances also when it is in action, the

oversupply of nutritious elements ingested must go somewhere, more or less directly, to produce disease in some other form, probably at first interfering with the action of the liver, and next appearing as gout or rheumatism, or to cause fluxes and obstructions of various kinds. Thus recurring attacks of gout perform the same duty, or nearly so, at this period of life, that the bilious attacks accomplished in youth, only the former process is far more damaging to the constitution and materially injures it. In relation to liver derangement and inordinate fat production, we may see the process rapidly performed before our eyes, if we so desire, in the cellars of Strasburg. For the unfortunate goose who is made by force to swallow more nutritive matter than is good for him in the shape of food which, excellent in appropriate conditions, is noxious to the last degree when not expended by the consumer—I mean good milk and barley-meal—falls a victim in less than a month of this gluttonous living to that form of fatty liver which under the name of *foie gras* offers an irresistible charm to the gourmet at most well-furnished tables.* The animal being thus fed is kept in a close, warm temperature and without exercise, a mode of feeding and a kind of life which one need not after all go to Strasburg to observe, since it is not difficult to find an approach to it, and to watch the principle carried out, although only to a less considerable extent, anywhere and everywhere around us. Numerous individuals of both sexes, who have no claim by the possession of ornithological characteristics to consanguinity with the animal just named, may be said neverless to manifest signs of relation in some sort thereto—not creditable perhaps—to the goose, the Strasburg dietary being an enforced one—by their habit of absorbing superfluous quantities of nutriment while living a life of inactivity, and of course sooner or later become invalid in body, unhappy in temper, and decrepit in regard of mental power.

For let us observe that there are two forces concerned in this matter of bountiful feeding which must be considered a little further. I have said that a hearty, active young fellow may eat, perhaps, almost twice as much as he requires to replace the expenditure of his life and repair the loss of the machine in its working without much inconvenience. He, being robust and young, has two functions capable of acting at the maximum degree of efficiency. He has a strong digestion, and can convert a large mass of food into fluid aliment suitable for absorption into the system: that is function the first. But, besides this, he has the power of bringing into play an active eliminating force, which rids him of all the superfluous materials otherwise destined,

* In passing I would strongly commend the condition of those poor beasts to the consideration of the Antivivisection Society, since more disease is artificially produced among them in order to furnish our tables with the "*pâté*" than by all the physiologists of Europe who in the interest, not of the human palate, but of human progress as affected by therapeutic knowledge, sometimes propagate and observe certain unknown forms of disease among a few of the lower animals.

as we have seen, to become mischievous in some shape: and that is function the second. To him it is a matter of indifference for a time whether the quantity of material which his food supplies to the body is greater than his ordinary daily expenditure demands, because his energy and activity furnish unstinted opportunities of eliminating the surplus at all times. But the neglect to adjust a due relation between the "income" and the "output" can not go on forever without signs of mischief in some quarter. A tolerably even correspondence between the two must by some means be maintained to insure a healthy condition of the body. It is failure to understand, first, the importance of preserving a near approach to equality between the supply of nutriment to the body and the expenditure produced by the activity of the latter, and, secondly, ignorance of the method of attaining this object in practice, which give rise to various forms of disease calculated to imbitter and shorten life after the period of prime has passed.

Let it be understood that in the matters of feeding and bodily activity a surplus of unexpended sustenance—here referred to as "the balance"—is by its nature exactly opposite to that which prudent men desire to hold with their bankers in affairs of finance. In this respect we desire to augment the income, endeavoring to confine expenditure within such limits as to maintain a cash balance in our favor to meet exigencies not perhaps foreseen. But, in order to preserve our health when that period of blatant, rampant, irrepressible vigor which belongs to youth has passed away, it is time to see that our income of food and our expenditure through such activity as we have constitute a harmonious equality, or nearly so. It is the balance against us of nutritive material which becomes a source of evil. And it is a balance which it is so agreeable and so easy to form, and which often so insidiously augments, unless we are on our guard against the danger. The accumulated stores of aliment, the unspent food, so to speak, which saturate the system are happily often got rid of by those special exercises to which so large a portion of time and energy is devoted by some people. It is to this end that men at home use dumb-bells or heavy clubs, or abroad shoot, hunt, and row, or perform athletic and pedestrian feats, or sweat in Turkish baths, or undergo a drench at some foreign watering-place—all useful exercises in their way, but pursued to an extent unnecessary for any other purpose than to eliminate superfluous nutrient materials, which are occasioning derangements in the system, for which these modes of elimination are the most efficient cure, and are thus often ordered by the medical adviser. But as we increase in age—when we have spent, say, our first half-century—less energy and activity remain, and less expenditure can be made; less power to eliminate is possible at fifty than at thirty, still less at sixty and upward. Less nutriment, therefore, must be taken in proportion as age advances, or rather as activity diminishes, or the individual will suffer. If he continues to consume the same abundant

breakfasts, substantial lunches, and heavy dinners, which at the summit of his power he could dispose of almost with impunity, he will in time certainly either accumulate fat or become acquainted with gout or rheumatism, or show signs of unhealthy deposit of some kind in some part of the body, processes which must inevitably empoison, undermine, or shorten his remaining term of life. He must reduce his "intake," because a smaller expenditure is an enforced condition of existence. At seventy the man's power has further diminished, and the nutriment must correspond thereto if he desires still another term of comfortable life. And why should he not? Then at eighty, with less activity there must be still less "support." And on this principle he may yet long continue, provided he is not the victim of an inherited taint or vice of system too powerful to be dominated, or that no unhappy accident inflicts a lasting injury on the machine, or no unfortunate exposure to insanitary poison has shaken the frame by long, exhausting fever; and then with a fair constitution he may remain free from serious troubles, and active to a right good old age, reaching far beyond the conventional seventy years which were formerly supposed to represent the full limit of man's fruitful life and work on earth.

But how opposed is this system to the favorite popular theory! Have we not all been brought up in the belief that the perfection of conduct consists, truly enough, in temperate habits in youth and middle life, such duty, however, being mostly enforced by the pleasant belief that when age arrived we might indulge in that extra "support" —seductive term, often fruitful of mischief—which the feebleness of advancing years is supposed to deserve? The little sensual luxuries, hitherto forbidden, now suggested by the lips of loving woman, and tendered in the confidence of well-doing by affectionate hands, are henceforth to be gratefully accepted, enjoyed, and turned to profit in the evening of our declining years. The extra glass of cordial, the superlatively strong extract of food, are now to become delicate and appropriate aids to the enfeebled frame. Unhappily for this doctrine, it is, on the contrary, precisely at this period that concentrated aliments are not advantageous or wholesome, but are to be avoided as sources generally prolific of trouble. If the cordial glass and the rich food are to be enjoyed at any time, whether prudently or otherwise, like other pleasures they must be indulged when strength and activity are great, in other words, when eliminating power is at its maximum, assuredly not when the circulation is becoming slow and feeble, and the springs of life are on the ebb. For the flow of blood can not be driven into any semblance of the youthful torrent by the temporary force of stimulants, nor is it to be overcharged by the constant addition of rich elements which can no longer be utilized. And thus it is impossible to deny that an unsuspected source of discomfort, which in time may become disease, sometimes threatens the head of

the household—a source which I would gladly pass over if duty did not compel me to notice it, owing as it is to the sedulous and tender care taken by the devoted, anxious partner of his life, who in secret has long noted and grieved over her lord's declining health and force. She observes that he is now more fatigued than formerly after the labors of the day, is less vigorous for business, for exercise, or for sport, less energetic every way in design and execution. She naturally desires to see him stronger, to sustain the enfeebled power which age is necessarily undermining; and with her there is but one idea, and it is practically embodied in one method—viz., to increase his force by augmenting his nourishment! She remonstrates at every meal at what she painfully feels is the insufficient portion of food he consumes. He pleads in excuse, almost with the consciousness of guilt, that he has really eaten all that appetite permits, but he is besought with plaintive voice and affectionate entreaty "to try and take a little more," and, partly to stay the current of gentle complaint, partly to gratify his companion, and partly, as with a faint internal sigh he may confess to himself, "for peace and comfort's sake," he assents, and with some violence to his nature forces his palate to comply, thus adding a slight burden to the already satiated stomach. Or if, perchance, endowed with a less compliant nature, he is churlish enough to decline the proffered advice, and even to question the value of a cup of strong beef-tea, or egg whipped up with sherry, which unsought has pursued him to his study, or been sent to his office between eleven and twelve of the forenoon, and which he knows by experience must if swallowed inevitably impair an appetite for lunch, then not improbably he will fall a victim to his solicitous helpmeet's well-meaning designs in some other shape. There is the tasteless calf's-foot jelly, of which a portion may be surreptitiously introduced into a bowl of tea with small chance that its presence will be detected, especially if accompanied by a good modicum of cream; or the little cup of cocoa or of coffee masking an egg well beaten and smoothly blended to tempt the palate—types of certain small diplomatic exercises, delightful, first, because they are diplomatic and not direct in execution; and, secondly, because the supporting system has been triumphantly maintained, my lord's natural and instinctive objections thereto notwithstanding.

But the loving wife—for whom my sympathy is not more profound than is my sorrow for her almost incurable error in relation to this single department of her duty—is by no means the only source of fallacious counsel to the man whose strength is slowly declining with age. We might almost imagine him to be the object of a conspiracy, so numerous are the temptations which beset him on every side. The daily and weekly journals display column after column of advertisements, enumerating all manner of edibles and drinkables, and loudly trumpeting their virtues, the chief of which is always declared to be the abundance of some quality averred to be at once medicinal and

nutritious. Is it bread that we are conjured to buy? Then it is warranted to contain some chemical element; let it be, for example, "the phosphates in large proportion"—a mysterious term which the advertising tradesman has for some time past employed to signify a precious element, the very elixir of life, which somehow or other he has led the public to associate with the nutriment of the brain and nervous system, and vaunts accordingly. He has evidently caught the notion from the advertising druggist, who loudly declares his special forms of half-food, half-physic, or his medicated preparations of beef and mutton, to contain the elements of nutrition in the highest form of concentration, among which have mostly figured the aforesaid "phosphates"—as if they were not among the most common and generally prevalent of the earthy constituents of all our food! Then, lest haply a stomach, unaccustomed to the new and highly concentrated materials, should, as is not improbable, find itself unequal to the task of digesting and absorbing them, a portion of gastric juice, borrowed for the occasion, mostly from the pig, is associated therewith to meet, if possible, that difficulty, and so to introduce the nourishment by hook or by crook into the system. I don't say the method described may not be useful in certain cases, and on the advice of the experienced physician, for a patient exhausted by disease, whose salvation may depend upon the happy combination referred to. But it is the popular belief in the impossibility of having too much of that or of any such good thing, provided only it consists of nutritious food, that the advertiser appeals to, and appeals successfully, and with such effect that the credulous public is being gulled to an enormous extent.

Then even our drink must now be nutritious! Most persons might naturally be aware that the primary object of drink is to satisfy thirst, which means a craving for the supply of water to the tissues—the only fluid they demand and utilize when the sensation in question is felt. Water is a solvent of solids, and is more powerful to this end when employed free from admixture with any other solid material. It may be flavored, as in tea and otherwise, without impairing its solvent power, but when mixed with any concrete matter, as in chocolate, thick cocoa, or even with milk, its capacity for dissolving—the very quality for which it was demanded—is in great part lost. So plentiful is nutriment in solid food, that the very last place where we should seek that quality is the drink which accompanies the ordinary meal. Here at least we might hope to be free from an exhortation to nourish ourselves, when desirous only to allay thirst or moisten our solid morsels with a draught of fluid. Not so; there are even some persons who must wash down their ample slices of roast beef with draughts of new milk!—an unwisely devised combination even for those of active habit, but for men and women whose lives are little occupied by exercise it is one of the greatest dietary blunders which can be perpetrated.

One would think it was generally known that milk is a peculiarly nutritive fluid, adapted for the fast-growing and fattening young mammal—admirable for such, for our small children, also serviceable to those whose muscular exertion is great, and, when it agrees with the stomach, to those who can not take meat. For us who have long ago achieved our full growth, and can thrive on solid fare, it is altogether superfluous and mostly mischievous as a drink.—*Nineteenth Century.*

[*To be continued.*]

AN EXPERIENCE WITH OPIUM.

By S. T. MORTON.

THE subject of the "opium-habit" is one that recurs with ominous frequency in public print. Whenever touched upon, the intensity of interest elicited in the minds of certain readers (alas! how large a number) would be incomprehensible to one not drawn personally to it. That the literature of this subject is mainly very discouraging and unhelpful to this class is perhaps not the fault of its authors; but such is uniformly the case. Of innumerable articles in periodicals and books by the dozen which I have read, it must be said that, while the evils of the "habit" are pictured in burning lines, when the discussion of treatment is reached, the *habitué* is left to believe that, in his case, if it be not impossible of cure, an attempt at total abandonment—with whatever medical skill he could command—would be attended with such hazards, and would inflict such tortures, mental and physical, as would be beyond the average power of endurance.

Unquestionably but a small portion of the general public—of those, too, who know something of its blighting evils—have any adequate idea of the strength of this "habit," and of the great difficulty, or impossibility, in most cases, of unaided cure. The chief responsibility, indeed, with the *habitué* lies in his initiation rather than in his continuance of the "habit." He can not, like the user of alcohol or tobacco, by a strong effort of the will shake off his chains.

A pathetic story has lately come to my knowledge of a young man, an under-graduate in an Eastern college, who had become a victim of the hypodermic use of morphia. He went with his father, who was engaged in the lumbering interest, into the primeval forests of Maine, hoping that during a stay of months with the wood-choppers he would be able to fight out the battle of gradual abandonment successfully. Through a strange fatality, when the party had just arrived at their camping-place, and were transporting their goods across a stream, the case of morphia was broken by an apparent accident and its contents

scattered into the water. None but the haggard young man could, at the moment, comprehend the appalling magnitude of the calamity —there, as he was, two hundred miles from the nearest settlement! He survived the terrible ordeal, but no words could express, he has said, the tortures and agony through which he passed during the succeeding weeks. He was closely watched, else, at times, he would have drowned himself or have beaten his brains out upon the rocks. Months afterward he came back to the world a skeleton, worn and haggard, from his terrible contest. It was an experience to which he could never afterward refer without the most painful emotions.

Not the least significant point in this veritable account is the fact that the young man always believed that his father had purposely brought about the catastrophe for the sake of bringing matters to a speedy end! Has the usual treatment of the disease by physicians at this day anything to offer that is much better than this man's summary method? Perhaps no work on the subject has appeared in recent years more careful and thorough in its scientific intention than Dr. Levinstein's "Morbid Craving for Morphia." It is evident that he has brought no common accuracy of observation to bear upon the subject. His clinical notes on a considerable number of cases of the disease treated by him are of absorbing interest to the morphia *habitué*.

There is a striking parallel between the method of the Maine lumberman I have described and that of advanced German science in the treatment of this disease. In both cases the patient suffers from the intense cruelty of ignorance! The best thing to do for the unfortunate victim of morphia, according to this learned work, is to secure him in rooms under charge of a competent keeper or nurse, his person and baggage having been searched, and from the rooms "all opportunities for attempting suicide having been removed. Doors and windows must not move on hinges, but on pivots; must have neither handles, nor bolts, nor keys; being so constructed that the patients can neither open nor shut them. Hooks for looking-glasses, for clothes, and curtains, must be removed." Certainly these are ominous preliminaries to a course of scientific medical treatment! Within this prison the patient is totally deprived at once of morphia in every form, and here he must struggle through the terrible weeks succeeding as best he may. So far as appears, he has but the slightest medical aid. His symptoms are closely watched, however, for the portentous shadow of one special danger looms ever near his bedside—that of a sudden collapse of his vital powers. A few moments' delay in such a contingency may prevent all power of resuscitation; in any case, the situation is very critical. Fortunate will it be if morphia, which is always the immediate resort in such emergencies, have not lost its potency!

I will not recount the story of the tortures through which the

patient passes—the days and nights of writhing, the sleeplessness, the restlessness, the thirst, and endless vomitings and purgings; his vain pleadings for liberty, for morphia, for anything which will relieve the intolerable anguish! These clinical notes of Levinstein's, in form cold and terse as a hardware catalogue, are fairly burning with their burden of tragedy. But this treatment he offers as the best known, and its attendant sufferings he evidently believes are inevitable in any cure!

It has happened to me to know, through personal experience, that the unfortunate victim of this "habit" can be freed from his bondage without passing through such an ordeal.

I had been an *habitué* ten years, having reached at the end of that period the daily amount of thirty-six grains of gum-opium, taken only into the stomach. The "habit" had been begun by a very small amount, and its increase had been extremely gradual. I knew not where to turn for help in effecting a cure: one thing seemed certain, it could not be done without help. At a venture merely, I called upon the late Dr. George M. Beard, feeling that, at any rate, I should be free from the risk of charlatanism; and I shall always remember him with gratitude, for it was through his recommendation that I placed myself under the care of another physician, who immediately undertook the treatment of my case.

The gentleman whom, through the good fortune of Dr. Beard's introduction, I thus came to know, I found to be a young man in the prime of good health and spirits, and one who at once inspired me with that confidence so important in such a case. His residence, it was manifest, was no ordinary "institute" or "asylum." I was simply a courteously received guest in a private family. Here were two bright children quietly pursuing their games when I first entered; and I was soon introduced to a pleasant circle embracing the cultivated ladies of the doctor's family, as well as the three who were to undertake the new path simultaneously with myself. Among these good fellows, as I soon found them to be, I was a simple layman in a medical "ring" as it were, for my comrades were young physicians, each under the hypodermic spell, doctors though they were, helpless like myself in the well-riveted chains. In this situation it is in no wise easy to follow the injunction, "Physician, heal thyself."

Placed in these easy and pleasant relations, with every comfort, and—a most important material consideration—an appetizing table, everything outward was calculated to inspire a feeling of freedom and cheerfulness. I speak particularly of these favorable surroundings, for they seem to me to form a very important accessory of the treatment.

This treatment differed in important respects from preconceived ideas, such as are fostered by almost everything written upon the subject. The patient here, for instance, was under no surveillance and

restraint. So far from being a prisoner, he was encouraged in taking walks and drives alone, or, with his fellow-patients, in attending evening amusements, etc. It was the doctor's theory that a person of any sensitiveness of nature could not rest under constant suspicion without a sense of resentment which would be prejudicial to the cordial relation which should always exist between physician and patient. "I ask for and extend confidence," he said, "and believe I largely enhance a good result in so doing. Nor do I share in the opinion, largely held, that no reliance is to be placed upon the word of the opium *habitué*." Though he was well aware that this morbid habit in many cases exerts a baneful influence on the moral character, it is manifest that—were the doctor's theory of his patient's reliability and truthfulness altogether erroneous—any plan of treatment based upon it would be entirely impracticable, however agreeable to the patients this view of their character.

Within a week after the beginning of treatment my opiate was all withdrawn. What I had undergone at the end of that period, and, indeed, for a day or two subsequent to the total discontinuance, could scarcely be called suffering; it was rather a dull, heavy listlessness, as little painful as enjoyable. There was no mental or physical elasticity; exercise was not inviting—nor, indeed, was there the physical ability for it. It became impossible to read or even to think, except in an idle way. There was no pain or nervousness; but principally a feeling of passive discomfort during this period, when the discontinuance of opium, unaided, would have brought on penal tortures.

Thus "the Rubicon was crossed"—this being the exultant phrase with which the doctor greeted one after the other of our little band, as he passed over that hitherto impassable stream. But the few days succeeding the total deprivation were not so passive. Though I had landed on the other bank of that classic stream, the tug of war was yet to come. That power in the human system which at times seems endowed with a personality of its own—that dual existence, as it were, with its Briarean arms of nerves—revolted. There was a period of disturbance and prostration of strength, with some restlessness. I was for a while the prey of illusions of sight and sound. "Materialized spirits" from the other world seemed at times to hover about my bed, as visible, if not as palpable, as the furniture of my room. But more deceptive still was a loud, sharp voice by which I was addressed occasionally, it seemed, by some person concealed behind the head-board of the bedstead; no speech of man will ever sound more real to me. These were illusions of my waking hours. But the period of prostration which they accompanied was short; and within a few days I again took my place at the table with the family.

More or less insomnia is probably inevitable under any circumstances after the discontinuance of opium. In my convalescence—and the experience was parallel with that of my fellow-patients—it was

the principal difficulty to overcome. At the worst, however, I passed no night without some sleep. Hypnotics were used at first, but were very soon altogether discontinued; for the sooner the system should discover, so to speak, that no outside aid was to be expected, the better.

The term of my stay under treatment was just four weeks, and the latter half of this may be considered the period of convalescence. There was soon an incoming tide of vitality that transformed the world. This came while my physical strength was still slight, and the amount of sleep to be obtained scanty. But the morning star had arisen above the horizon, and brought an indescribable feeling of renewed hope and courage. Perhaps no after-experience of life will bring again that exquisite sensitiveness to every emotional touch which lasted for two or three days at this early stage of recovery, when the soul was bathed in an atmosphere of joy, and the most commonplace incident would excite a thrill of bliss—when a chance strain of music would bring tears of rapture. This, of course, was not a normal condition, but was the effect of reaction in the newly awakened powers of the system. One main symptom thereafter was a peculiar lassitude—inertia. The will-power seemed to be under some strange thralldom, and one found himself under the greatest difficulty in bringing himself to perform some of the simplest actions. Another symptom—which persisted in some cases much longer than it did in others—was what may be called a dislocation of ideas, or at least a lack of relation between thought and its embodiment in language. The patient would have great difficulty in finding the right expression; he would use words with a most ridiculous misapplication, to his intense mortification. He could not, for the life of him, "call a spade a spade," but would call it almost any other implement or thing imaginable. In my own case, however, this trouble was slight.

At the end of my four weeks' stay I had nearly recovered my regular hours of sleep, and had gained very materially in general tone and strength. With the exception noted above, I had been receiving only tonic treatment; and after leaving my physician's care the only medicines taken were quinine, in tonic doses, and cod-liver oil. It is unnecessary to recount here all the stages of convalescence. Very soon after leaving I had a period of two or three weeks of wonderful elasticity—in fact, of the most perfect health. But this was soon succeeded by a return of the former lassitude and disturbance. There were many such oscillations in the succeeding months; there were periods when the past seemed blotted out in a sense of renewed vigor and strength, followed by weeks when, without any immediate ostensible cause, the tide was at ebb. These were not times of mental despondency, but rather of physical depression and neuralgic disturbance. But there was all the while a steady improvement in general health, with an increasing infrequence of reminders of the "old

enemy." During the first three months I gained over twenty pounds in weight.

There is one thing which the *habitué* wishing to be cured would perhaps anticipate with dread; that is, an insatiable craving for the old stimulant, and a consequent prolonged and weary resistance of temptation. I can only say that, greatly to my surprise, I have felt no craving for it at any time since the beginning of my treatment. This may seem a strange statement to any one under the sorcery of the drug, and conscious of its fearful grip. There is of course the knowledge, from experience, of the marvelous potency of opium in annulling all discomfort and distress of body or mind; but this is all. The sense of profound satisfaction, ever present, at the release from its slavery, as well as a lively appreciation of the great danger of again tampering with it, is sufficient to leave the temptation—whatever it may be—from such knowledge, powerless.

The special effect of opium on the system is *functional.* This fact is one great encouragement in attempting a cure from the "habit." The sudden recuperative power manifested, after this paralyzing deadweight is removed, is a great surprise to the patient. Difficulties which had borne to him the grave aspect of serious organic disease vanish as by magic.

There was no secret about this treatment—there were no wonderful remedies unknown to the world used. The therapeutics included bromide of sodium, hot baths, electricity, and other well-known sedative and tonic medicines. The key-stone of the treatment is in preliminary sedation; that is, while the morphia is being rapidly withdrawn —during a period varying from seven to ten days—the nervous system is, at the same time, as rapidly brought under the influence of an efficient sedative, which reaches its maximum effect at the time of complete opiate withdrawal.

Two years have passed since my escape from the thralldom of opium, and during the far larger portion of that time I could record an experience of renewed vitality—a condition of vigor and elasticity that could only have its origin in perfect health. I use no stimulants whatever, other than tea and coffee; and my health has now been so long fully re-established that I feel the better assured in giving some account of my personal experience. I shall be glad if the narrative be of encouragement to others in the same strait—those who have heretofore believed escape from their situation only possible through prolonged agonies. The inevitable chasm which must be crossed in effecting a cure of the opium-disease can be bridged, as I found. One must know something of the breadth and depth of that chasm, to be able to appreciate the achievement.

SOME SELF-MADE ASTRONOMERS.

By E. LAGRANGE.

OUR purpose is to inquire briefly, illustrating our research by a few eminent examples, how men become astronomers, or, in general, how those who achieve distinction in that profession are directed to it. No one is destined to astronomy from his childhood. No fathers in forecasting the future of their sons ever think of preparing them especially for so unpractical a business, one so far from any of the roads to fortune as the study of the skies. Some particular conditions, independent of parental views of the career their sons are to follow, outside of anything that is contemplated in arranging the course of their studies in school, must contribute to lead a youth to consecrate his life to this pursuit. How, then, we ask again, does one become an astronomer? Well, he begins by taking up some other career—that of watch-maker, for instance, or of writing-master, clergyman, revenue officer, carpenter, bookseller, doctor, or perhaps shepherd, musician, or tradesman; and then, some day, if the thing is to be, some little incident determines it: the die is cast, and he becomes an astronomer. Nothing in particular is done; there are no parental lamentations or reproaches of friends who think you are a fool; you go your way, to the university if you can pay the cost, or straight to the observatory of which you are to become the director, to the disgust of the assiduous students who have been cramming for the examinations. This is the history of Hansen. He was watch-maker, and was called in one day to a scientific man's house to repair a clock. Having to wait a little while in the laboratory till the gentleman came in, he casually picked up a book, which proved to be a geometry. The man of science came in, and, finding him interested in the book, lent it to him. Hansen devoured it; the man lent him other books, and he gave himself up to them as a miss would to a novel she was forbidden to read. Two years after this, Hansen, at thirty years of age, was director of the observatory at Gotha, where he performed his celebrated labors on the motions of the moon.

Mädler was a writing-master till he was forty-five years old, when all at once it came into his head to make an astronomer of himself. He obtained a place at the private observatory of Beer (brother of Meyerbeer), where he drew a map of the moon. Shortly afterward, he was placed by the Russian Government at the head of the Dorpat Observatory, where he continued till his death, at the age of eighty-three years.

Brunhs, director of the Leipsic Observatory, who died a short time ago, was found by Humboldt in a locksmith's shop in Berlin, and obtained through his influence a place in the observatory.

Leverrier, who died Director of the Paris Observatory, and who occupied himself more than any other astronomer with calculations of the motions of the planets, was intended to be an engineer. He was employed in the excise, when he suddenly discovered that the science of the skies was his vocation. It is well known that astronomy owes to him the discovery of the planet Neptune, which was the result of a mathematical calculation.

Olbers, who contributed so much to the theory for determining the orbits of comets, was a practicing physician in Bremen. He was accustomed to spend his evenings at home, after the day's round of calls, in reading for pleasure works on astronomy, to which science he rendered considerable services, while as a doctor he was in no way distinguished from the host of his competitors.

Th. von Oppolzer, to whom science is indebted for some splendid labors, intended first to embrace the career of his father, who was a distinguished physician ; but he had hardly got his first case, when he was seized by the demon of astronomy ; and he forever abandoned his early profession to devote himself to that science.

The great Herschel was a hautboy-player in a Hanoverian regiment, and the thought of being an astronomer never occurred to him till he was forty years old. At that time he wanted to get a telescope, and, as he had no means with which to buy one, he made one himself, and with it discovered Uranus. He was then made a doctor at Oxford, and entered the service of the English Government, with whose aid he was able to build his monster telescope. He afterward explored the sky to very remote depths, discovering nebulæ, and studying double stars and clusters of stars.

The astronomers whose stories have just been told are not exceptions. It must rather be admitted, as a general rule, that all the men who have made epochs in astronomy were deserters, or persons who had left some other profession to engage in astronomy. The academicians may confront me, on this point, with the life of the great Gauss. This celebrated astronomer, one of the greatest of all time, did indeed follow the direct road, but that was only because of his having, when he was young, attracted the attention of the Duke Charles William Ferdinand of Brunswick. It is very probable that, but for this circumstance, he would have become something very different, perhaps a mason, or a fountain-builder, or an employé of the burial-office—three trades which his father carried on together. But it is quite as certain that Gauss would sooner or later have become an astronomer as that Raphael, as Lessing says, would have become a painter, even if he had lost his hands.

Frederick William Bessel, one of the most eminent astronomers of the nineteenth century, had been destined by his father to become a merchant, and the young man, who had a strong distaste for Latin and considerable fondness for mathematics, engaged in his studies

with relish, but did not particularly distinguish himself in them. When fifteen years of age, on the 1st of January, 1799, he began his apprenticeship to the merchant's career in a large commercial house of Bremen, with a good-will. No one, and himself least of all, would have dreamed then of his ever becoming celebrated. He was not at all ambitious, and did not even seem to care to put himself in advance of his colleagues. The only thing to remark about him was the conscientiousness with which he did his work. After this was done, he would recreate himself by poring over old books, trying to make himself familiar with all branches of commerce, and studying particularly maritime commerce, in which he was specially interested. He was thinking about his future, and perceived early that, to make his fortune, he would have to try his lot across the sea, for he had no means wherewith to establish himself.

The object of his desire at this time was to be able, as agent of one of the great houses of Bremen or Hamburg, to direct a commercial expedition to the Indies or China. With this purpose he diligently studied English and French, and then bethought himself of what else might be useful to him in the career he wished to embrace. Till this time we see in his conduct no evidence of a disposition toward astronomy. He was simply seeking to become a good merchant, and all his efforts, day and night, were directed to that end. He was in heart a merchant, and in course of becoming one, and yet we can not doubt that there was developing in him at the very time the tendency which was to lead him to the science of the sky.

In the course of the studies of which we have spoken, it occurred to him that a ship-factor, such as he was going to be, undertaking long voyages, and playing so prominent a part on the ship, ought to know a little of the way in which it was to be directed. He had heard that a new art had been discovered—that of sailing in the open sea by observation of the stars, the moon, and the sun. Although the sailors of the period cared to learn nothing of this new art, Bessel hoped that by becoming master of it he might make himself respected by his future captain. It was necessary to procure a sextant; but that was beyond the means of our clerk, so he made one for himself, and assiduously took observations of the stars with it. He determined the latitude and longitude of Bremen, as if he had been on board his vessel. Thus, at nineteen years of age, he had set foot in the astronomical field. He never left it, but delved in it more and more, though without neglecting his commercial studies. He made his astronomical recreations the occupation of his evening hours. It is with astronomy as with love—the smallest spark is enough to kindle a lasting fire, if only the subject is inflammable. This was what happened with Bessel, and the flame that was lighted in his spirit was never extinguished.

The young man had read in his new book how, from the observa-

tion of the stars, one might calculate the geographical position of the spot where he happened to be. He sought to know why this was so. For this purpose he had to study mathematics from its rudiments, and was thus led up rapidly to spherical astronomy. He had to be continually introducing the elements of the position of the sun and moon into his calculations, taking them from an astronomical calendar. He desired to calculate these elements for himself. He was thus led to study the laws of the motions of the celestial bodies. The net which astronomical science had cast over him was thus wrapping him closer every day, and in less than a year after he had begun his astronomical studies he undertook the computation of the orbit of the comet of 1607, a work that involved three hundred pages of calculations, and which a skilled astronomer might regard as the task of a year. He was not a little proud of his calculations when he had completed them, and he determined to make the acquaintance of Olbers, who was practicing medicine in Bremen, and was regarded as the first authority in everything that related to comets. Meeting the famous doctor in the street, he timidly told him he had calculated the orbit of a comet, and asked him to have the kindness to examine his work. Olbers granted the request, supposing that he was about to receive the work of an amateur, whom he must treat politely, for fear of discouraging him. But he was greatly surprised when he examined the calculations, and he immediately wrote to Bessel: "I have read your work on the comet of 1607 with very great pleasure. It gives me a very high idea of your astronomical and mathematical knowledge, and of your skill in the most difficult departments of calculation. If I should criticise you on any point, it would be only on your having given more time and care to the ancient observations than they deserve." If we place this praise of Olbers by the side of the fact that Bessel did not know a word of mathematics or astronomy a year before, or hardly that there was such a thing as the mechanics and mathematics of the sky, and if we also recollect that he was occupied from eight o'clock in the morning till night with something entirely different, we can gain a slight idea of the great energy and the rare mental constancy which he must have displayed, and which afterward carried him so far.

Bessel's fate was decided. He was recommended by Olbers to Gauss, who, in the same year, invited him to assist him in the calculations with which he was occupied. Bessel accepted the invitation with enthusiasm, and, according to his habit, made the calculations with more precision than was required. From that time Gauss and Bessel were connected in a lasting scientific friendship. Bessel was to wait another year before giving himself up entirely to astronomy, but early in 1806, warmly supported by Olbers, he was appointed inspector of a private observatory at Lilienthal. He remained there four years, till his reputation brought him a call to the direction of the new ob-

servatory at Königsberg. At twenty-six years of age, without ever having been in a university, he took rank as one of the first professors in the University of Königsberg.

We thus see that Bessel was, in the broadest sense of the word, a self-made man. But it can not be said that he was a genius. Ideas did not come to him as the manna to the children of Israel in the desert. He acquired all his knowledge solely by his excessive application and by his indomitable energy in pursuing the end he was aiming at. I do not think that his natural talent exceeded the mean which Nature has given to all. We feel, in reading Bessel, not the sense of a sudden induction—which is frequently given to the mathematician as well as to the astronomer—but rather that of a continuous labor, which draws new and exact conclusions from materials previously accumulated, and knows how to make a practical use of.—*Translated for the Popular Science Monthly from Ciel et Terre.*

ON LEAVES.

By Sir JOHN LUBBOCK.

I.

MR. RUSKIN, in one of his most exquisite passages, has told us that "flowers seem intended for the solace of ordinary humanity: children love them; tender, contented, ordinary people love them. They are the cottager's treasure; and in the crowded town mark, as with a little broken fragment of rainbow, the windows of the workers in whose heart rests the covenant of peace." I should be ungrateful indeed did I not fully feel the force of this truth; but yet it must be confessed that the beauty of our woods and fields is due at least as much to foliage as to flowers.

In the words of the same author, "The leaves of the herbage at our feet take all kinds of strange shapes, as if to invite us to examine them. Star-shaped, heart-shaped, spear-shaped, arrow-shaped, fretted, fringed, cleft, furrowed, serrated, sinuated, in whorls, in tufts, in spires, in wreaths, endlessly expressive, deceptive, fantastic, never the same from footstalk to blossom, they seem perpetually to tempt our watchfulness and take delight in outstripping our wonder."

Now, why is this marvelous variety, this inexhaustible treasury of beautiful forms? Does it result from some innate tendency of each species? Is it intentionally designed to delight the eye of man? or have the form, and size, and texture some reference to the structure and organization, the habits and requirements, of the whole plant?

I do not propose now to discuss any of the more unusual and abnormal forms of leaves: the pitchers of *Nepenthes* or *Cephalotus*, the pitfalls of *Sarracenia* or *Darlingtonia*, the spring-trap leaves of *Dionæa*, the scarcely less effective though less striking contrivances in our own *Drosera* or *Pinguicula*, nor the remarkable power of movement which many leaves present, whether in response to an external stimulus, as in certain mimosas, oxalises, etc., or as a spontaneous periodic movement, such as the "sleep" of many leaves, or the nearly continuous rotation of the lateral leaflets of *Desmodium*. I propose, rather, to ask you to consider with me the structure, and especially the forms, of the common every-day leaves of our woods and fields.

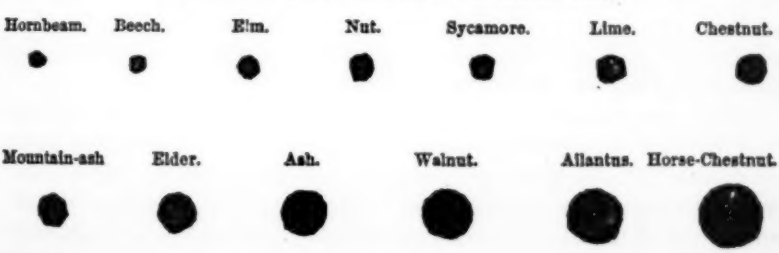
In talking the subject over with friends, I have found a widely prevalent idea that the beauty and variety of leaves are a beneficent arrangement made specially with reference to the enjoyment and delight of man. I have, again, frequently been met by the opinion that there is some special form, size, and texture of leaf inherently characteristic of each species; that the cellular tissue tends to "crystallize," as it were, into some particular form, quite irrespective of any advantage to the plant itself.

Neither of these will, I think, stand the test of careful examination.

In the first place, let us consider the size of the leaf. On what does this depend? In herbs we very often see that the leaves decrease toward the end of the shoot, while in trees the leaves, though not identical, are much more uniform, in size.

Again, if we take a twig of hornbeam, we shall find that the six terminal leaves have together an area of about fourteen square inches, and the section of the twig has a diameter of ·06 of an inch. In the beech the leaves are rather larger, six of them having an area of perhaps eighteen inches, and, corresponding with this greater leaf-surface, we find that the twig is somewhat stouter, say ·09 of an inch. Following this up we shall find that, *cæteris paribus*, the size of the leaf has relation to the thickness of the stem. This is clearly shown in the following table:

Impression of Stalk below the Sixth Leaf.



	Diameter of stem in inches.	Approximate area of six upper leaves in inches.
Hornbeam	·06	14
Beech	·09	18
Elm	·11	34
Nut	·13	55
Sycamore	·13	60
Lime	·14	60
Chestnut	·15	72
Mountain-ash	·16	60
Elder	·18	93
Ash	·18	100
Walnut	·25	220
Ailantus	·3	240
Horse-chestnut	·3	300

In the elm the numbers are ·11 and 34, in the chestnut ·15 and 72, and in the horse-chestnut the stem has a thickness of ·32, and the six leaves have an area often of three hundred square inches. Of course, however, these numbers are only approximate. Many things have to be taken into consideration. Strength, for instance is an important element. Thus the ailantus, with a stem equal in thickness to that of the horse-chestnut, carries a smaller area of leaves, perhaps because it is less compact. Again, the weight of the leaves is doubtless a factor in the case. Thus in some sprays of ash and elder which I examined of equal diameter, the former bore the larger expanse of leaves; but not only is the stem of the elder less compact, but the elder-leaves, though not so large, were quite as heavy, if not indeed a little heavier. I was for some time puzzled by the fact that, while the terminal shoot of the spruce is somewhat thicker than that of the Scotch fir, the leaves are not much more than one third as long. May this not perhaps be due to the fact that they remain on more than twice as long, so that the total leaf area borne by the branch is greater, though the individual leaves are shorter? Again, it will be observed that the leaf area of the mountain-ash is small compared to the stem, and it may, perhaps, not be unreasonable to suggest that this may be connected with the habit of the tree to grow in bleak and exposed situations. The position of the leaves, the direction of the bough, and many other elements would have also to be taken into consideration, but still it seems clear that there is a correspondence between thickness of stem and size of leaf. This ratio, moreover, when taken in relation with the other conditions of the problem, has, as we shall see, a considerable bearing not only on the size, but on the form of the leaf also.

The mountain-ash has been a great puzzle to me; it is, of course, a true *Pyrus*, and is merely called ash from the resemblance of its leaves to those of the common ash. But the ordinary leaves of a pear are, as we all know, simple and ovate, or obovate. Why, then, should those of the mountain-ash be so entirely different? May not, perhaps, some light be thrown on this by the arrangement of the leaves? They are

situated some distance apart, and though, as shown in the table, they are small in comparison to the diameter of the stem, still they attain a size of fifteen square inches, or even more. Now, if they were of the same form as the ordinary pear-leaf, they would be about seven inches long by two to three in breadth. The mountain-ash, as we know, lives in mountainous and exposed localities, and such a leaf would be unsuitable to withstand the force of the wind in such situations. From this point of view, the division into leaflets seems a manifest advantage.

Perhaps it will be said that in some trees the leaves are much more uniform in size than in others. This is true. The sycamore, for instance, varies greatly; in the specimen tabulated, the stem was ·13 in diameter, and the area of the six upper leaves was sixty square inches. In another, the six upper leaves had an area of rather over one hundred inches, but in this case the diameter of the stem was ·18.

Another point is the length of the internode. In such trees as the beech, elm, hornbeam, etc., the distance from bud to bud varies comparatively little, and bears a tolerably close relation to the size of the leaf. In the sycamore, maple, etc., on the contrary, the length varies greatly.

Now, if, instead of looking merely at a single leaf, we consider the whole bough of any tree, we shall, I think, see the reason of their differences of form.

Let us begin, for instance, with the common lime (Fig. 1). The leaf-stalks are arranged at an angle of about 40° with the branch, and the upper surfaces of the leaves are in the same plane with it. The

Fig. 1.

Fig. 2.

result is, that they are admirably adapted to secure the maximum of light and air. Let us take, for instance, the second or third leaf in Fig. 1. They are four and a half inches long and very nearly as broad. The distance between the two leaves on each side is also just four and a half inches, so that they exactly fill up the interval. In *Tilia parvifolia* the arrangement is similar, but leaves and internodes are both less, the leaves, say, one and a half inch, and the internodes ·6.

In the beech, the general plane of the leaves is again that of the branch (Fig. 2), but the leaves themselves are ovate in form, and smaller, being only from two to three inches in length. On the other hand, the distance between the internodes is also smaller, being, say, one and a quarter inch against something less than two inches. The diminution in length of the internode is not, indeed, exactly in proportion to that of the leaf, but, on the other hand, the leaf does not make so wide an angle with the stem. To this position is probably due the difference of form. The outline of the basal half of the leaf fits neatly to the branch, that of the upper half follows the edge of the leaf beyond, and the form of the inner edge being thus determined decides the outer one also.

In the nut (*Corylus*), the internodes are longer and the leaves correspondingly broader. In the elm (*Ulmus*, Fig. 3), the ordinary branches have leaves resembling, though rather larger than, those of the beech; but in vigorous shoots the internodes become longer and the leaves correspondingly broader and larger, so that they come nearly to resemble those of the nut.

But it may be said the Spanish chestnut (*Castanea vulgaris*, Fig. 4) also has alternate leaves in a plane parallel to that of the branch, and

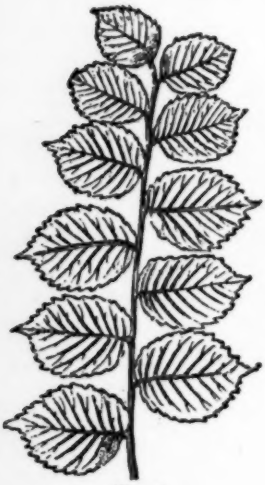


FIG. 3.

FIG. 4.

FIG. 5.

with internodes of very nearly the same length as the beech. That is true; but, on the other hand, the terminal branches of the Spanish chestnut are stouter in proportion. Thus, immediately below the sixth leaf, the chestnut-stalk may be ·15 of an inch in thickness, that of the beech not much more than half as much. Consequently, the chestnut could, of course supposing the strength of the wood to be equal, bear a greater weight of leaf; but, the width of the leaf being determined by the distance between the internodes, the leaf is, so to

say, compelled to draw itself out. In Fig. 5 I have endeavored to illustrate this by placing a spray of beech over one of Spanish chestnut. Moreover, not only do the leaves on a single twig thus admirably fit in with one another, but they are also adapted to the ramification of the twigs themselves. Fig. 6 shows a bough of beech seen from above, and it will be observed that the form of the leaves is such that, while but little space is lost, there is scarcely any overlapping. Each fits in perfectly with the rest.

The leaves of the yew (Fig. 7) belong to a type very different from those which we have hitherto been considering. They are long, narrow, and arranged all round the stem, but spread right and left,

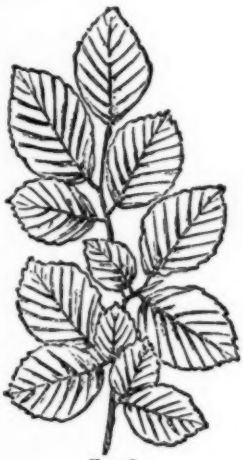


Fig. 6.

Fig. 7.

Fig. 8.

so that they lie in one plane, parallel to the direction of the branchlet, and their width bears just such a relation to their distance apart that when so spread out their edges almost touch. Fig. 8 represents a sprig of box. It will be observed that the increase of width in the leaves corresponds closely with the greater distance between the points of attachment.

The leaves of the Scotch pine (*Pinus sylvestris*) are needle-like, one and a half inch in length and one twentieth in diameter. They are arranged in pairs, each pair inclosed at the base in a sheath. One inch of stem bears about fifteen pairs of leaves. Given this number of leaves in such a space, they must evidently be long and narrow. If I am asked why they are longer than those of the yew, I would suggest that the stem, being thicker, is able to support more weight. In confirmation of this, we may take for comparison the Weymouth pine, in which the leaves are much longer and the stalk thicker.

When we pass from the species hitherto considered to the maples (Fig. 11), sycamores, and horse-chestnuts (Figs. 9 and 10), we come to a totally different type of arrangement. The leaves are placed at right

angles to the axis of the branch instead of being parallel to it, have long petioles, and palmate instead of pinnate veins. In this group the mode of growth is somewhat stiff; the main shoots are perpendicular, and the lateral ones nearly at right angles to them. The buds, also, are comparatively few, and the internodes, consequently, at greater distances apart, sometimes as much as a foot, though the two or three at the end of a branch are often quite short. The general habit is shown in Figs. 9 and 10. Now, if we were to imagine six beech or

FIG. 9.

FIG. 10.

elm leaves on these three internodes, it is obvious that the leaf surface would be far smaller than it is at present. Again, if we compare the thickness of an average sycamore-stem below the sixth leaf with that of a beech-stem, it is obvious that there would be a considerable waste of power. Once more, if the leaves were parallel to the branch, they would, as the branches are arranged, be less well disposed with reference to light and air. A glance at Figs. 9, 10, and 11, however, will show how beautifully the leaves are adapted to their changed conditions. The blades of the leaves of the upper pair form an angle with the leaf-stalks, so as to assume a horizontal position, or nearly so; the leaf-stalks of the second pair decussate with those of the first, and are just so much longer as to bring up that pair nearly, or quite, to a level with the first; the third pair decussate with the second, and are again brought up nearly to the same level, and immediately to the outside of the first pair. In well-grown shoots there is often a fourth pair on the outside of the second. If we look at such a cluster of leaves directly from in front, we shall see that they generally appear

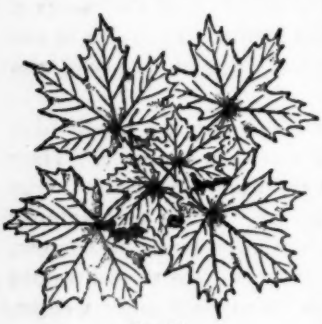


FIG. 11.

somewhat to overlap; but it must be remembered that in temperate regions the sun is never vertical. Moreover, while alternate leaves are more convenient in such an arrangement as that of the beech, where there would be no room for a second leaf, it is more suitable in such cases as the sycamores and maples that the leaves should be opposite, because, if, other things remaining the same, the leaves of the sycamore were alternate, the sixth leaf would require an inconvenient length of petiole.

Perhaps it will be said that the plane-tree, which has leaves so like a maple that one species of the latter genus is named after it (*Acer platanoides*), has, nevertheless, alternate leaves. In reality, however, I think this rather supports my argument, because the leaves of the plane, instead of being at right angles to the stem, lie more nearly parallel with it. Moreover, as any one can see, the leaves are not arranged so successfully with reference to exposure as those of the species we have hitherto been considering, perhaps because, living as it does in more southern localities, the economy of sunshine is less important than in more northern regions.

The shoot of the horse-chestnut is even stouter than that of the sycamore, and has a diameter below the sixth leaf of no less than three tenths of an inch. With this increase of strength is, I think, connected the greater size of the leaves, which attain to as much as eighteen inches in diameter, and this greater size, again, has perhaps led to the dissection of the leaves into five or seven distinct segments, each of which has a form somewhat peculiar in itself, but which fits in admirably with the other leaflets. However this may be, we have in the horse-chestnut, as in the sycamores and maples, a beautiful dome of leaves, each standing free from the rest, and expanding to the fresh air and sunlight a surface of foliage in proportion to the stout, bold stem on which they are borne.

Now, if we place the leaves of one tree on the branches of another, we shall at once see how unsuitable they would be. I do not speak of putting a small leaf such as that of a beech on a large-leaved tree such as the horse-chestnut; but if we place, for instance, beech on lime, or *vice versa*, the contrast is sufficiently striking.

The lime-leaves would overlap one another, while, on the other hand, the beech-leaves would leave considerable interspaces. Or let us in the same way transpose those of the Spanish chestnut (*Castanea*) and those of *Acer platanoides*, a species of maple. I have taken specimens in which the six terminal leaves of a shoot of the two species occupy approximately the same area. Figs. 4 and 11 show the leaves in their natural position, those of *Castanea* lying along the stalk, while those of *Acer* are ranged round it. In both cases it will be seen that there is practically no overlapping, and very little waste of space. In *Castanea* the stalks are just long enough to give a certain play to the leaves. In *Acer* they are much longer, bringing the leaves

approximately to the same level, and carrying the lower and outer ones free from the upper and younger ones.

Now, if we arrange the Spanish-chestnut leaves round a center, as in Fig. 12, it is at once obvious how much space is wasted. On the other hand, if we attach the leaves of the *Acer* to the stalk of *Castanea* at the points from which the leaves of *Castanea* came off, as in Fig. 13,

FIG. 12.

FIG. 13.

we shall see that the stalks are useless, and even mischievous, as a cause of weakness and of waste of space; while, on the other hand, if we omit the stalks, or shorten them to the same length as those of *Castanea*, as in Fig. 14, the leaves would greatly overlap one another.

Once more, for leaves arranged as in the beech the gentle swell at the base is admirably suited; but in a crown of leaves, such as those of the sycamore, space would be wasted, and it is better that they should expand at once as soon as their stalks have borne them free from those within. Moreover, the spreading lobes leave a triangular space (Fig. 11) with the insertion of the stalk at the apex, which seems as if expressly designed to leave room for the pointed end of the leaf within.

FIG. 14.

Hence we see how beautifully the whole form of these leaves is adapted to the mode of growth of the trees themselves and the arrangement of their buds.

Before we proceed to consider the next series of species to which I wish to direct attention, it will be necessary for me to say a few words on the microscopical structure of the leaf. Although so thin, the leaf consists of several layers of cells. Speaking roughly, and as a general rule, we may say that on each side is a thin membrane, or epidermis, underneath which on the upper side are one or more layers of elongated

cells known from their form as "pallisade-cells," beneath which is a parenchymatous tissue of more or less loose texture. The leaf is strengthened by ribs of woody tissue. From this general type there are, of course, numerous variations. For instance, some water-plants have no epidermis.

If the surface of the leaf be examined with a tolerably high power, small opaque spots will be observed, resembling a sort of button-hole, with a thick rim or border composed of two more or less curved cells, the concavities being turned inward. When dry, they are nearly straight, and lie side by side; but when moistened they swell, become somewhat curved, and gape open.

It is difficult to realize the immense number of these orifices or "stomata" which a single bush or tree must possess when we remember that there are sometimes many thousand stomata to a square inch of surface. In a large proportion of herbs the two sides of the leaf are under conditions so nearly similar that the stomata are almost equally numerous on the upper and on the lower side. In trees, however, as a general rule, they are found exclusively on the under side of the leaf, which is the most protected; they are thus less exposed to the direct rays of the sun, or to be thoroughly wetted by rain, so that their action is less liable to sudden and violent changes.

There are, however, some exceptions; for instance, in the black poplar the stomata are nearly as numerous on one side of the leaf as on the other. Now, why is this? If we compare the leaves of the black and white poplar, we shall be at once struck by the fact that, though these species are so nearly allied, the leaves are very different. In the white poplar (*Populus alba*), the upper and under sides are very unlike both in color and texture, the under side being thickly clothed with cottony hairs. In the black poplar (*P. nigra*, Fig. 15), the upper and under surfaces are, which is not frequent, very similar in color and texture. The petioles or leaf-stalks, again, are unlike; those of *P. nigra* presenting the peculiarity of being much flattened at the end toward the leaf. The effect of the unusual structure of the petiole is that the leaf, instead of being horizontal as in the *P. alba* and most trees, hangs vertically, and this again explains the similarity of the two surfaces, because the result is that both surfaces are placed under nearly similar conditions as regards light and air. Again, it will be observed that, if we attempt to arrange the leaves of the black poplar on one plane, they generally overlap one another; the extent is larger than can be displayed without their interfering with one another. In foliage arranged like that, for instance,

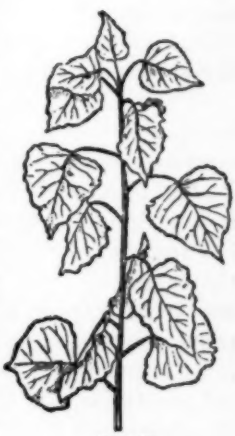


FIG. 15.

of the beech, elm, sycamore, or, in fact, of most of our trees, this would involve a certain amount of waste; but in the black poplar, as Fig. 15 shows, the leaves when hung in their natural position are quite detached from one another.

Another interesting case of a species with vertical leaves is the prickly lettuce (*Lactuca scariola*), while those of *L. muralis* and *L. virosa* are horizontal. With this position of the leaves is connected another peculiarity, especially well marked in the so-called "compass" plant of the American prairies (*Silphium laciniatum*), a yellow composite not unlike a small sunflower, which is thus named because the leaves turn their edges north and south. This has long been familiar to the hunters of the prairies, but was first mentioned by General Alvord, who called Longfellow's attention to it, and thus inspired the lines in "Evangeline":

> "Look at this delicate plant, that lifts its head from the meadow,
> See how its leaves are turned north, as true as the magnet;
> This is the compass-flower, that the finger of God has planted
> Here in the houseless wild to direct the traveler's journey
> Over the sea-like, pathless, limitless waste of the desert."

The advantage of this position, and consequently the probable reason for its adoption, is that in consequence of it the two faces of the leaf are about equally illuminated by the sun; and in connection with this we find that the structure of the leaf is unusual in two respects. The stomata are about equally abundant on both surfaces, while pallisade-cells, which are generally characteristic of the upper surface, are in this species found on the lower one also.

The leaves of the *Lactuca scariola* have also, when growing in sunny situations, a tendency to point north and south. Under such circumstances also they have a layer of pallisade-cells on each side.

Hitherto I have dealt with plants in which one main consideration appears to be the securing as much light and air as possible. Our English trees may be said as a general rule to be glad of as much sun as they can get. But a glance at any shrubbery is sufficient to show that we can not explain all leaves in this manner, and in tropical countries some plants at any rate find the sun too much for them. I will presently return to the consideration of the general characteristics of tropical vegetation. In illustration, however, of the present point, perhaps the clearest evidence is afforded by some Australian species, especially the eucalypti and acacias. Here the adaptations which we meet with are directed, not to the courting, but to the avoidance, of light.

The typical leaves of acacias are pinnate, with a number of leaflets. On the other hand, many of the Australian acacias have leaves (or, to speak more correctly, phyllodes) more or less elongated or willow-like. But if we raise them from seed we find, for instance, in *Acacia salicina*, so called from its resemblance to a willow, that the first leaves are pin-

nate (Fig. 16), and differ in nothing from those characteristics of the genus. In the later ones, however, the leaflets are reduced in number, and the leaf-stalk is slightly compressed laterally. The fifth or sixth leaf, perhaps, will have the leaflets reduced to a single pair, and the

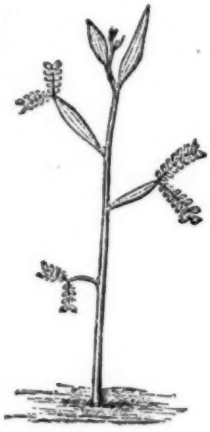


FIG. 16.

FIG. 17.

leaf-stalk still more flattened, while, when the plant is a little older, nothing remains except the flattened petiole. This in shape, as already observed, much resembles a narrow willow-leaf, but flattened laterally, so that it carries its edge upward, and consequently exposes as little surface as possible to the overpowering sun. In some species the long and narrow phyllodes carry this still further by hanging downward,

FIG. 18.

FIG. 19.

and in such cases they often assume a cimeter-like form. This I would venture to suggest may be in consequence of one side being turned outward, and therefore under more favorable conditions.

In one very interesting species (*Acacia melanoxylon*, Fig. 17), the

plant throughout life produces both forms, and on the same bough may be seen phyllodes interspersed among ordinary pinnate leaves, the respective advantages being, it would appear, so equally balanced that sometimes the one, sometimes the other, secures the predominance.

In the case of the eucalyptus, every one who has been in the south of Europe must have noticed that the young trees have a totally different aspect from that which they acquire when older. The leaves of the young trees (Fig. 18) are tongue-shaped, and horizontal. In older ones, on the contrary (Fig. 19), they hang more or less vertically, with one edge toward the tree, and are cimeter-shaped, with the convex edge outward, perhaps for the same reason as that suggested in the case of acacia. There are several other cases in which the same plant bears two kinds of leaves. Thus, in some species of juniper the leaves are long and pointed, in others rounded and scale-like. *Juniperus chinensis* has both.

In the common ivy the leaves on the creeping or climbing stems are more or less triangular, while those of the flowering stems are ovate-lanceolate, a difference the cause of which has not, I think, yet been satisfactorily explained, but into which I will not now enter.—*Contemporary Review.*

EARTHQUAKE PHENOMENA.

By RALPH S. TARR.

AT the present time the earth seems to be in a state of great seismological action. Different parts of the world have recently been disturbed by earthquakes which have caused wide-spread destruction. Those in Spain, which began December 24th, and have lasted, with slight interruption, down to the time of writing, have been among the most destructive of recent earthquakes. Over two thousand people have been killed, many more wounded, and thousands of houses destroyed. Such a state of affairs can not help arousing an interest in this phenomenon.

The earth is constantly quivering, some point on the surface being the seat of a slight quake nearly every moment of the day. By far the larger number of these are of little intensity, being felt only by delicate instruments, and the majority of cases come from volcanic regions. So few facts are known, that we can neither draw deductions nor even determine the causes. It is reported, however, that earthquakes more commonly occur at night, and that they are more abundant in winter than in summer.

The only settled facts about earthquakes are, that they are the result of some shock imparted to the rocks at a considerable distance beneath the surface, and that this shock reaches the surface in a series

of concentric rings, all points on the circumference of each ring receiving the shock at the same moment, even though they may be hundreds of miles apart. In other words, all points at equal distances from the center of the earthquake receive the shock at the same moment. Although this is theoretically the case, according to well-known physical laws, still, in practice, the facts are somewhat different; for the shock is retarded or accelerated according as the rock opposes or favors the passage of the wave. The severity of the shock in a given place is dependent upon a variety of causes. These are: 1. The strength of the original shock; 2. The distance from the earthquake center; and, 3. The kind of rock on which one is standing, loose gravels greatly diminishing the force of the shock. The destructiveness of earthquakes depends rather upon the suddenness of application than the amount of motion. In that at Rio Bomba, it is reported for a fact that a man was hurled across a stream a distance of one hundred feet, and landed on an elevation fifty feet higher than his original position. It is an undoubted fact that objects are frequently thrown great distances. In the Mississippi Valley, during the earthquakes of 1811 to 1814, the tops of trees were twisted and entangled, and strong log-cabins were thrown to the ground. Rivers are sometimes checked in their flow, and, in past geological ages, some have been completely turned from their course by earthquakes.

At least four theories have been seriously advocated by scientists to explain these phenomena. The first, which is now abandoned, is based upon the supposition that the earth's interior is in a fluid condition. This being the case, the combined action of the sun and moon upon this molten mass beneath the surface causes it to surge and swing in tides of liquid fire. It is the shock from this that we feel on the surface. (I dismiss this theory, as one having no value whatever).

Another theory is, that earthquakes are due to volcanic action. The passage of the immense quantities of gas which escape from volcanoes must necessarily cause shock after shock. This gas, under pressure of thousands of pounds, is contained in a subterranean boiler, from which it is continually trying to escape. The moment the pressure becomes sufficient, the walls in some part give way, and the transmission of this shock reaches us as an earthquake. When the pent-up gases have broken through successive strata, always coming nearer to the surface, they finally reach the uppermost stratum, and this, which has been weakened by previous eruptions, gives way before the pressure, and lets the steam out as a volcanic eruption. It is thus, then, that the continual succession of earthquakes in volcanic regions is produced. When, however, we study the country about many earthquakes, and find no evidence of volcanoes, we are forced to abandon this theory for those regions, and look further. This is the case with all New England earthquakes, and with those in Spain.

Let us look at the next theory. We all know that water is continually soaking into the ground, and is dissolving out all matter which it can. Limestone is one of these substances, and it is to this property that we owe the great caverns of Kentucky. Water not only works on or near the surface, but it even penetrates thousands of feet into the earth, and at this depth possesses even greater power of solution. Indeed, we have every reason to believe that deep down in the earth's crust vast caverns have been excavated by this erosion of water, and that in some places, especially limestone regions, these are numerous. Granting, then, that there are such great holes in the ground, and supposing that one of them should suddenly collapse, we can readily imagine a shock which would cause wide-spread devastation. But this theory also will apply merely to certain limited localities, and we have not yet found a general theory—one for all regions.

Let us travel for a moment in a mountainous region, and we will see thousands of feet of rock folded, twisted, and bent in every conceivable manner. Now, it is a well-proved fact that these rocks were originally deposited in a horizontal layer, and that they have since undergone contortion. It can be conceived, then, that such rocks must be in a constant state of strain ready to relieve themselves at any favorable moment. Let us suppose that we have a long board held down on each end by a bank of earth. Remove a part of one bank, and a point will be reached when the board will spring up with considerable force, striking anything above it a severe blow. This is the condition of our mountain-rocks. Material is constantly being eroded from some and piled upon others. The time finally comes when they snap or spring, and, striking the rocks above, send out an earthquake shock. Quarrymen frequently feel a slight shock and immediately after hear a report, showing that the strain in some rock has been relieved. A most curious instance is reported where a very long column of granite rock was being split from a quarry by the use of wedges. At last the mass was split from the bed, and instantly it expanded itself with such suddenness as to produce a very perceptible jar; and when the rock was returned to the place where it originally lay it no longer fitted, and the drill-holes did not coincide as before. Here, then, we have an earthquake on a small scale started by artificial means. Probably many of the slight shocks result from similar causes, or from the action of frost, or by contraction and expansion caused by the daily change in temperature.

These, then, are the theories for earthquakes, but neither of the three can be called general. We can usually tell when volcanic action is the cause, and are thus limited in our choice to two. In some cases the cavern theory may apply, but these are rare, and can usually be determined, so that in any region not volcanic the third theory is the most probable. This accounts for the fact that earthquakes are much

more frequent and violent in mountain-regions of recent origin. The Appalachian, which are the oldest mountains in America, are, therefore, very free from earthquakes, because the rocks have, as a rule, long since relieved themselves; while, on the other hand, the comparatively new Rockies are the seat of more frequent tremblings.

There is a theory for the cause of earthquakes, which is rather neglected by scientific men, but which, I think, will explain many of those phenomena not otherwise accounted for.

At the mouth of the Ohio, and at Newburyport, Massachusetts, both of which have in times past been the seat of very severe earthquake shocks, the layers of rocks are not badly bent. And, further, I do not see how the theory of bent rocks can explain the frequent repetition of shocks which we have recently seen in Spain, in Newburyport in 1727, and near the mouth of the Ohio in 1811. These regions had been comparatively quiet for years, and suddenly a severe shock was felt, followed by a series of successive shocks, which, in the case of Spain, have not yet ceased, although the original shock occurred December 24, 1884. The theory, which I have spoken of, and which would explain this, is that there are great quantities of gas accumulated at certain points beneath the surface under great pressure, and that this gas, in its attempt to free itself, bursts open the rocks, causing shock after shock, until it has finally relieved itself sufficiently to remain quiet. This, one will see, is similar to the volcanic theory, except that there is no necessity for the presence of a volcano. What this gas is, does not matter; it may be accumulations of steam, or it may be evolved from petroleum, or it may be carbonic-dioxide gas evolved by acids working on calcareous rocks. In the Newburyport earthquake, which was the most severe ever recorded in New England, large quantities of gas escaped to the surface; and, on the Ohio, gas also escaped. This shock, which was at first wide-spread, finally narrowed itself down to a very limited marshy area and died out.

To sum up, then, it may be said: 1. That in volcanic regions earthquakes are a part of an eruption, premonitory warnings; 2. That in a limestone country the falling in of the walls of caverns may account for some; 3. That in regions of recent mountain-making the sudden release of tension causes many; 4. That the pressure of pent-up gases on the surrounding rocks, which are finally burst, may be the cause of a large number, more especially those which are followed by a long-repeated series of shocks; and, finally, that in any one of these regions either or all of the other causes may (with the exception of volcanic in non-volcanic regions) enter into the production of earthquakes.

CURIOSITIES OF STAR-FISH LIFE.*

By FREDERIK A. FERNALD.

FOR a dozen years past, the eminent English zoölogist, who has become so widely known as an investigator of animal intelligence, has spent his summers at the sea-side, studying several common forms of marine life. He compares a season's work of this kind to a prolonged picnic, the pleasure of which is accompanied by a sense that no time is being profitlessly spent. Sailing about upon the sunny sea to dip up in muslin nets the creatures at the surface, steaming away far from shore to dredge for other material, and carrying on observations among the tanks and bell-jars of a neat little airy workshop, all have their charms. Even the necessity of devising makeshift apparatus, and of teaching unskilled hands how to help, adds to the enjoyment, as does the overcoming of similar obstacles in a pleasure-excursion. Dr. Romanes has devoted his attention mainly to jelly-fish, star-fish,

FIG. 1.—UPPER SURFACE OF A STAR-FISH (*Astropecten*). (From Cassell's "Natural History.")

FIG. 2.—PEDICELLARIÆ (magnified). (From Cassell's "Natural History.")

* The material and illustrations of this article are drawn from "Jelly-fish, Star-fish and Sea-urchins," by Dr. G. J. Romanes, the latest issue in the International Scientific Series.

and sea-urchins, or more particularly to the nervous systems, and the movements controlled by them, in these creatures.

A star-fish, as we all know, consists of a central disk and five radiating arms (Fig. 1). Upon the whole of the upper surface occur numerous calcareous nodules imbedded in the soft flesh, and supporting short spines. One of these nodules, much larger than the others, is always found a little to one side of the center, and is called the madreporic tubercle (Fig. 1, *m*). With the aid of a lens we may see also on the upper surface a number of small organs, each consisting of a pair of pincers supported on a flexible stalk, scattered about among the calcareous nodules, or attached to the spines; these are known as pedicellariæ (Fig. 2). These organs are provided with muscles by which the stalk is swayed about, and the pincers are opened and shut. What it is that these curious organs are adapted to seize, and therefore of what use they are in the economy of the animal, has long been a puzzle to naturalists, but Dr. Romanes and his associate, Professor Ewart, have succeeded in throwing some light on this point. In some species of star-fish the size of the central disk is increased so as to fill up the spaces between the rays, the form of the animal thus becoming a pentagon. In other species the reverse process has taken place, the rays having become relatively longer, and, being at the same

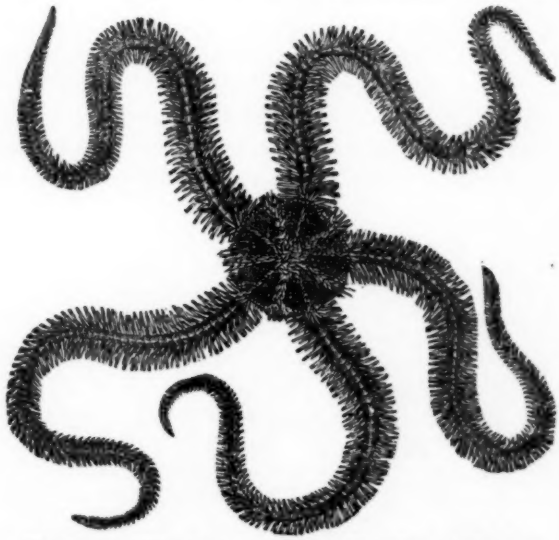


FIG. 3.—A BRITTLE-STAR. (From Cassell's "Natural History.")

time very active, they look like five little snakes joined together by a small circular disk (Fig. 3). Again, in another species the rays branch, these branches again branch, and so on till the animal looks like a mat. Turning now the under surface of our star-fish uppermost, we see that the mouth is in the center of the disk, and that from the mouth radiate

five grooves, each extending to the tip of one of the five rays (Fig. 7). On each side of these grooves are many actively moving membranous tubes, which are used for crawling, and are called the pedicels or feet. They are closed at the free end, but communicate by a system of tubes within the body of the animal with the madreporic tubercle. It has been surmised that this tubercle acts as a filter to the sea-water which, with some admixture, forms the liquid circulating in the tubes, and Dr. Romanes has proved the surmise to be correct; for colored fluid, injected under pressure into any part of the system of tubes, found its way to the madreporic tubercle, and oozed through its porous substance. The tube-feet are thrust forth or withdrawn by being distended with liquid or emptied. With the exception of a few at the tip of each arm, every tube-foot bears a sucker (Fig. 4); these suckers are pressed closely to a flat surface by filling the tube-feet with liquid; the pressure within the tubes is then lessened, and the greater pressure of the surrounding water holds the suckers fast. They are released by increasing the pressure of the liquid within the tube-feet.

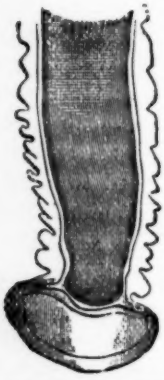


FIG. 4.—THE TERMINAL PORTION OF A TUBE-FOOT (magnified).

The common star-fish usually crawls in a determinate direction, the feet on the tip of the foremost ray being used as feelers. In a tank, when the star-fish has ascended the side and reaches the surface of the water, it often performs peculiar movements which may be called acrobatic. The animal does not wish to leave its native element—in fact, can not do so, because its sucking feet can act only under water—neither does it wish to descend at once.

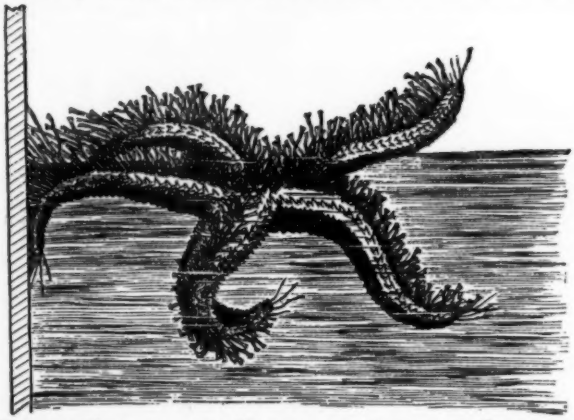


FIG. 5.—NATURAL MOVEMENTS OF A STAR-FISH ON REACHING THE SURFACE OF WATER.

It therefore crawls along the side of the tank, now and then throwing back its uppermost ray or rays to feel about for rocks or sea-weed (Fig. 5). If it finds any solid support it will very likely attach its

uppermost rays to it, and then, letting go its other attachments, swing from the old support to the new. The activity and co-ordination manifested in these acrobatic movements, says Dr. Romanes, are surprising, and give to the animal an almost intelligent appearance.

The feet of astropecten are partly rudimentary, having lost their terminal suckers, and these star-fish assist themselves in locomotion by the muscular movements of their rays. The brittle-stars are still further removed in the same direction from the common star-fish; their tubular feet are of no use for crawling, while their rays are so long, flexible, and muscular, as to enable them to shuffle quite rapidly over horizontal surfaces. Two opposite arms are used upon the floor with the motion of swimming, the animal leaping forward about two inches at each stroke, and, as these leaps follow one another quickly, the star-fish is able to travel at the rate of six feet a minute. A common star-fish can crawl only two inches a minute. Some of the *Comatulæ*, in which the muscularity of the rays has proceeded still further, are able actually to swim by the co-ordinated movements of their rays.

The sea-urchin, or echinus, is a modification of the star-fish structure, having the form of a flattened sphere, and is covered with hard spines (Fig. 6). In the living animal these spines are movable in all directions, each being mounted on a ball-and-socket joint, and provided with muscles at its base. Like the star-fish, the echinus has a madreporic tubercle, pedicellariæ, and feet. If we shave off the spines and pedicellariæ, we come down to a hard shell, which is hollow and filled with liquid. The liquid resembles sea-water, but is richly corpusculated, and coagulates when exposed to the air. Five double rows of holes extend symmetrically from pole to pole of the shell. It is through these holes that the feet are thrust out, so that in its main features an echinus is merely a star-fish with its five rays curved into the shape of a hollow spheroid, and then converted into a rigid box, with holes left for its feet to come through. The urchin crawls in the same way as the common star-fish, but makes use of its spines also to help push itself along. The suckers, moreover, in being protruded from all sides of a globe instead of from the under side of a flat organism, are of much more use as feelers than they are in the star-fish. If

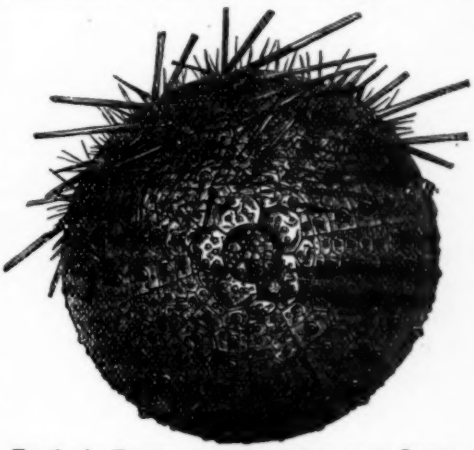


FIG. 6.—AN ECHINUS PARTLY DENUDED OF ITS SPINES. (From Cassell's "Natural History.")

the animal while walking be turned half round, it will continue its movements as before, and hence will proceed in a direction opposite to its former one. When at rest, some of the feet are used as anchors, and others protruded as feelers.

All species of the *Echinodermata*, when turned upon their backs, are able to right themselves. The brittle-stars can easily perform the

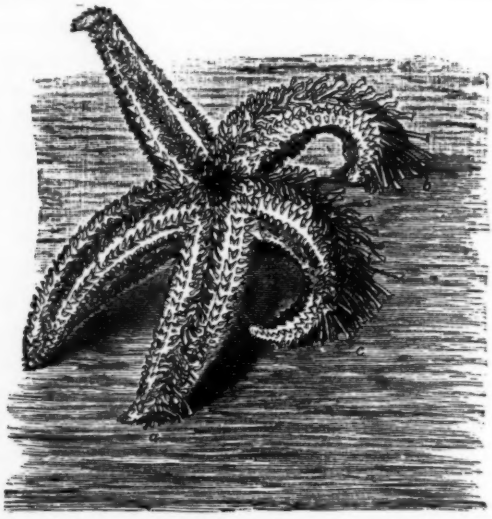


FIG. 7.—NATURAL RIGHTING MOVEMENTS OF COMMON STAR-FISH.

needful manœuvre by wriggling some of their snake-like arms under the inverted disk, and heaving the whole body over by the mere muscularity of these members. The common star-fish, however, experiences more difficulty, and executes the manœuvre mainly by means of its suckers. It twists round the tip of one or more of its rays until the feet there situated are able to get a firm hold of the floor (Fig. 7,

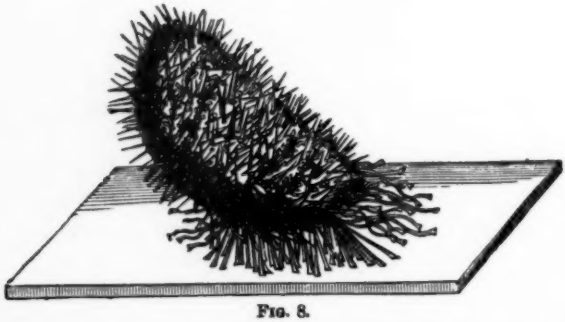


FIG. 8.

a), then, by successive action of the feet further back in the series, the whole ray is twisted round (*b*), so that the under surface of the end is applied flat against the floor (*c*). The semi-turn or spiral then travels

on down the ray. Usually two or three adjacent rays perform this manœuvre simultaneously, the spirals of the co-operating rays being invariably turned in the same direction, and, when they have proceeded sufficiently far to drag over the remaining rays, these then abandon their hold on the bottom so as not to offer any resistance to the lifting action of the active rays. The whole movement does not occupy more than half a minute.

But it is in the case of echinus that these righting movements become most interesting, from the fact that they are so much more difficult to accomplish. Two, or perhaps three, adjacent rows of suckers are chosen out of the five to accomplish the task. As many feet in these rows as can reach the floor are thrust downward and fastened firmly to it; by their combined action, as by the pull of liliputian ropes, the globe is tilted slightly in their own direction, the anchoring feet in the opposite rows releasing their hold on the floor to admit of this tilting (Fig. 8). The next feet in the active rows are thus enabled to reach the floor, and, when they have established their hold, they assist in increasing the tilt; then the next feet in the series lay hold, and so on, the globe slowly but steadily rising until it stands upon its equator (Fig. 9). The difficulty of raising such a heavy mass into this

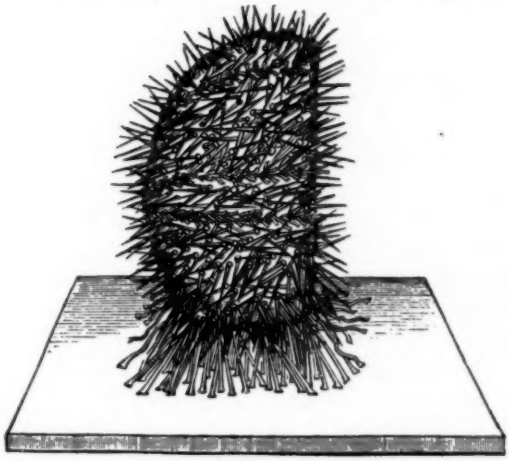


FIG. 9.

position by means of the slender motive power available is manifest not only from the extreme slowness with which it takes place, but because specimens not perfectly strong may fail completely to reach the position of resting on the equator. Moreover, in some cases when this position has been reached with difficulty, the echinus gives itself a breathing-space, as it were, before beginning its descent. It will be perceived that, as soon as the descent begins, gravity is no longer an obstacle but an aid to the righting movement, and it might be anticipated that the echinus would now simply let go all its attach-

ments and allow itself to roll over into its natural position. But an echinus will never let go its attachments without some urgent reason, seeming to be above all things afraid of being rolled about at the mercy of currents, and therefore it lets itself down almost as slowly as it pulled itself up (Fig. 10).

Single rays separated from a star-fish crawl as fast as the entire animal, and likewise in a determinate direction. They also crawl up

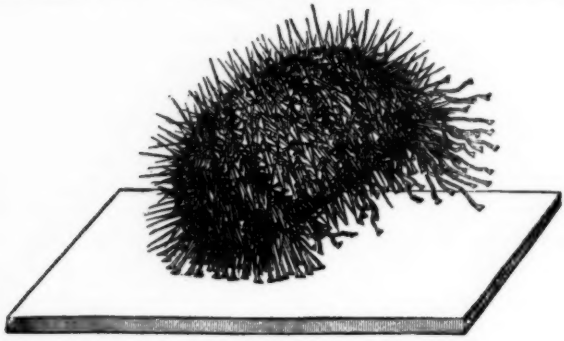


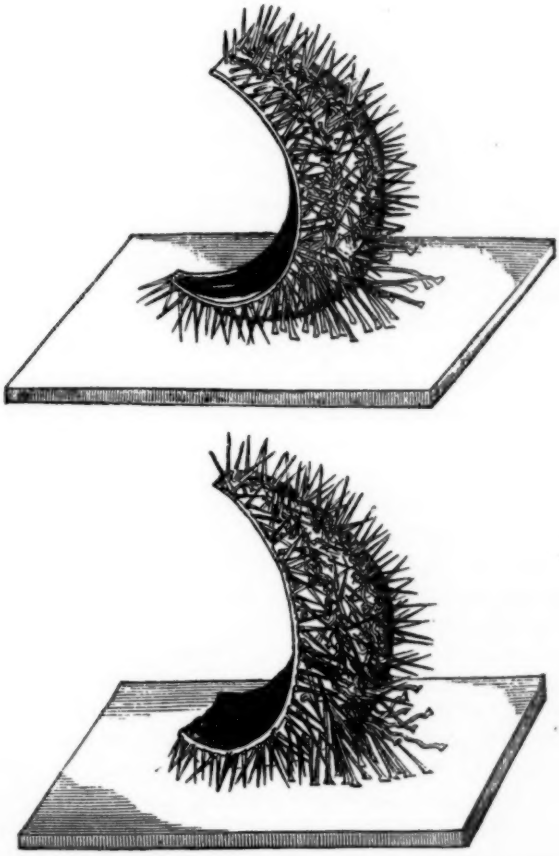
Fig. 10.

perpendicular surfaces, and when inverted right themselves as quickly as do the unmutilated creatures. A segment of an echinus bearing a single row of ambulacral feet, when propped up on its ab-oral pole, (Fig. 11) will right itself after the manner of entire animals (Fig. 12). It, however, experiences more difficulty in doing so, and very often fails to complete the manœuvre. Such a segment is, of course, analogous to a single detached ray of a star-fish; but on account of the rigid consistence and awkward shape of the segment—standing erect instead of lying flat—it presents a much more curious appearance in locomotion than does the ray of a star-fish.

Dr. Romanes reports observations which show conclusively that the whole external surface, not only of the soft and fleshy star-fish, but even of the hard and rigid echinus, is everywhere sensitive to stimulation. This sensitiveness, moreover, is highly delicate. If any part of the external surface of an echinus is lightly touched with the point of a needle, all the feet, spines, and pedicellariæ within reach of that part, and even beyond it, immediately close in upon the needle and grasp it tightly. This simultaneous movement of such a little forest of prehensile organs is a very beautiful spectacle to witness. Here we have proof of the function of the pedicellariæ. In climbing perpendicular or inclined surfaces of rock covered with waving sea-weeds, it must be of no small advantage to an echinus to be provided on all sides with a multitude of movable stalks bearing forceps, which can instantly seize a passing frond. The frond being thus arrested, the spines come to the assistance of the pedicellariæ, and both together hold the sea-weed steady till the ambulacral feet have time to

establish their hold upon it with their sucking-disks. This operation may be witnessed by drawing a piece of sea-weed over a healthy echinus in the water.

The capability of the spines for co-ordinated action is highly remarkable and interesting. Thus, for instance, if an urchin be taken



FIGS. 11 AND 12.—RIGHTING AND AMBULACRAL MOVEMENTS OF SEVERAL SEGMENTS OF ECHINUS.

out of the water and placed upon a table, it is no longer able to use its feet for walking, as the suckers can act only under water. Yet the animal is able to progress slowly by means of its spines, which are used to prop and push the globe-like shell along in some continuous direction. If a lighted match be held in front of the moving animal, as soon as the echinus comes close enough to feel the heat, all the spines begin to make the creature move away in the opposite direction. There is an urchin-like form of echinoderm called spatangus, which differs from the echinus in having shorter feet and longer spines. When, therefore, a spatangus is inverted it is unable to right itself

by means of its short feet, but uses its long spines to perform the manœuvre. The process is a tedious one, and there are generally numerous failures; but the creature perseveres until it eventually succeeds.

ETHICS AND THE DEVELOPMENT THEORY.

By GEORG VON GITZYCKI.

THE question of the bearing of the theory of evolution upon morals deserves a serious examination. The doctrine of development breaks at many points with cherished traditional notions, and its opponents have predicted that it would result in a spiritual revolution which would convulse society to its foundations by destroying the sanctions of conscience and paralyzing the religious sense.

The science of ethics has a theoretical and a practical part; the former, founded on the study of the nature of volition and the moral feelings, the latter having for its object to determine what ought to be. The latter, the establishment of rules of conduct, is the real object of ethics, while the purely theoretical researches have only the value of means.

Ethics can, it appears to us, learn much out of the theory of development, or can at least find a confirmation of single principles hitherto recognized by only a part of the students of morals. This theory teaches that the feelings and inclinations, as well as the bodily forms, are results of the adaptation of the living being to the conditions of his existence, and are therefore to be recognized as life-maintaining functions; that, the more complicated are the conditions of life, the less perfect is this adaptation: therefore, in the human world, spontaneous feelings and impulses are not safe guides. We may learn from it, also, to regard the moral feelings and conceptions as the most important part of the adapting of man to the conditions of social existence. It teaches us to bring into special consideration the moral conceptions of the most successful nations in the struggle for existence; for, if their views of right and wrong had diverged greatly from what is really beneficial to society, they would not have reached their dominant position. But the recognition that, in consequence of the complicated conditions of life, the adaptation is never complete, must restrain us from ever regarding the "positive morals" of a people—that is, the sum of their actual moral ideas—as being absolutely perfect.

The development theory, which has made us acquainted, as perhaps no former generation has been, with the idea of progress, has also accustomed us to regard the moral as one of the fields in which progress takes place; and, furthermore, to look forward to perfection in the

moral nature. Moral progress consists, not in men coming nearer to their ideals, but in their ideals reaching a higher plane.

This theory shows us how dependent man is upon his race, and how erroneous it is to separate him from that connection. That the faculty of conscience is a result of the adaptation of man to the conditions of social existence appears to be doubted by no adherent of the theory of development; but the exponents of the doctrine vary greatly in their views of the manner in which the moral conceptions arise in individual life. Some regard them as to a greater or less extent instinctive, or transmitted by inheritance from the accumulated experience of ancestors; while others are inclined to accord a more prominent agency in the matter to training. We may apparently, however, presume that that which is practically the most wholesome will endure in the character, provided the teacher does not trust too much to the innate moral instincts, but recognizes that, while his child has the qualities requisite to his becoming a moral man under favorable conditions, this is not sure to be the case if those conditions are wanting, and therefore exercises extreme care in moral instruction.

We turn next to the answer to the question, What is the bearing of the development theory on the practical part of ethics? Man's place in Nature, as determined by that theory, is very different from that indicated in the older ideas of men; just as the Nature in which man finds himself set is not the Nature that existed in the conceptions of the past. The new conception of man and his morals again approaches, in many respects, that which was implied in the ethics of classical antiquity. Man no longer stands outside of Nature, but within it, as one of its integral parts. He is subject to the same laws of life as the animals. All in him, like all around him, is a product of natural, regular development. Even his moral part is not something laid upon him from outside of Nature, but something which has been shaped out of his own nature, molding itself according to the conditions of his existence. To an ethicist who accepts this view, morals will appear an affair of humanity and for humanity—for humanity on earth; and will give the most comprehensive construction of the saying of Christ, that man is not made for the Sabbath, but the Sabbath for man. We can not perceive that this view involves any practically destructive tendencies; and there are not a few distinguished men who avow the belief that there is no irreconcilable variance between evolution and religion.

With this view of the place of man in Nature, the ethicist can not easily oppose the doctrine that the same legality rules in the human will as in all the other processes of Nature. Even in the matter of the appearance of new individuals, the development theory admits no void in the endless chain of causation; for the dispositions which man brings into the world are, in consequence of it, nothing else than a product of the energies of his predecessors. The recognition of the

fact of the transmissibility of mental as well as of physical characteristics, if not to the children to the children's children—a transmissibility whose sphere of influence in individual cases is not susceptible of definition—can not but heighten the feeling of responsibility, because we are thereby made aware that the consequences of good as well as of bad conduct extend further than we had supposed.

A few adherents of the development theory, including Darwin himself, have held that not the good of mankind, but the maintenance of his existence, is the moral principle resulting from it; and that feelings of pleasure and of pain are only the means which Nature uses to promote the exercise of life-favoring and restraint from life-injuring conduct; that the real end of all action is not pleasure and the avoidance of pain, not the greatest possible excess of pleasure over pain for as many as possible, not the greatest good of the greatest number, but only the most prolonged existence of the greatest number. The greatest possible endurance of species, or the mere maintenance of species, not their welfare, would be according to this view the chief moral principle. This position appears to us to be a difficult one.

The chief moral principle expresses that from which all of the rules of right may be derived, and accordingly means the highest rule of conduct, the highest moral aim of life, or the ethical highest good, and serves as the highest standard of estimation and judgment. Those evolutionists of whom we have just spoken start from a teleological view of the world—from the view that the course of Nature is governed by some purpose. But the majority of the Darwinians are opponents of teleology, or try to be. Rolph has shown that, in following the history of organic development on the earth, we can really perceive no tendency to an adaptation showing design, to the production of forms that may be represented to human conception as higher. Its result has been only to produce forms better adapted to what is around them; and the change just as often consists in a deterioration, even though some advantage is always gained for the creature. As not final causes, but efficient causes, working causes, have worn out the river-bed and determined the course of the stream, as it has formed its channel not with reference to its final outlet, but to the local conditions, so, as Darwin and his followers have shown, it is with all organic phenomena. The investigator has to break with teleology in all its forms; and, even in ethics, the question of the object, of the destiny of man, will have to be given up. This idea of a purpose or design in Nature, when we come to analyze it, of a preconceived and voluntary operation working to produce determined effects, presumes by necessary implication the agency of a will behind the causes which are leading up to those effects. It follows, hence, that there is purpose in Nature in the domain of man and the higher animals, because men, and in a certain but very much less degree the animals, form conceptions of processes which they strive to carry through; but that

aside from these one can speak of Nature's purposes, of purposes which general Nature is pursuing, only if he regards Nature as a thinking and volitional being, or as the creature of such a being. A teleological view of the world thus of necessity always includes some kind of a theological view; and it seems to be decidedly a *non-sequitur* to entertain the one without holding to the other.

We men actually make our continued existence an object of fundamental importance, because, without realizing it, no other object is attainable. We are thus justified in calling all our properties that contribute to the maintenance of life adapted to that purpose. And, as we refer this same relation to the animal and the whole organic world, we are accustomed also to designate all their life-maintaining properties as likewise adapted. But life is never a purpose to animals. The idea of preserving life does not arise in their consciousness, and can not therefore be the object of a volition; while the lower animals have no ideas, but only sensations and perceptions. They have, therefore, no purposes. Still less can we speak of the purposes of plants, for plants have no consciousness. It is thus clear that, so far as the sub-human world is concerned, the designation of the life-preserving attributes of existence as designed, unless we are speaking in a theological sense, is only metaphorical. For this designation implies the premise that life is an object; and this, in a proper, untheological sense, is true only as respects human consciousness. Thus, a speaker who would avoid transcendental implications and metaphorical modes of speech should always avoid the word "designed," and this can be done without leaving any fact undetermined.

But, if we, regarding our belief in God as a justification for the introduction of the divine idea into science, and not heeding the many difficulties which ethics has hitherto encountered in basing its precepts on the presumed will of God, endeavor to determine what his will is, we shall have very little, if any, success in convincing the faithful that it is for the most prolonged existence of the greatest number.

Even as relating to men, these persons will not believe that self-preservation as such is the highest good. Bare existence is no good, much less the highest good; but it may be, if it is a bad existence, the highest evil, and this according to the perfectionist doctrine as well as according to the utilitarian theory of happiness. There is said to be existence, yes, eternal existence, even in hell; and, according to the ancient fathers of the Church, "the most prolonged existence for the greatest number."

Evolutionists, who recognize that life is valuable only as it is good, have occasionally fallen into the mistake of considering among the consequences of conduct only the effects on the condition of soundness, and of disregarding the pain that may be immediately produced by it; and they have not always been mindful that, according to their own

definitions, fullness of life can be valuable only if we include in it fullness of happiness or some cause thereof.

Those evolutionists who appeal to the ancient principle of a Nature-fitted life have apparently not sufficiently considered one thing. Science teaches what has been, but not what will be. If the "tendencies" of Nature which they think they have determined were simply laws of Nature, conditions of the inevitable occurrence of events, there would be no reason in seeking to make a moral imperative of them; for that can not be a matter of injunction which will without fail happen of itself. But if those "tendencies" are not a fate to be fulfilled with irresistible necessity, but can be antagonized, then the question arises, Why should we act according to them, and not try to counteract them? If we were once agreed that the complete working out of those tendencies would cross all our desires and hopes, would we recognize the ethic imperative of promoting them? On the contrary, we should recognize the obligation of so far as possible preventing their realization. And we should obey the moral command to make those tendencies ours, and advance them according to our strength so far as they appear good to us; as we also should hold a corresponding conduct to be right without this, without regarding it as advancing natural tendencies. What we should regard as good or evil, as worth striving for or to be avoided, must present a corresponding character to our own perception; and what that is arises out of our own nature, not out of something different from what that might be. Thus, the final decision as to what is to be striven for and what to be avoided lies in us, in our mind and will.

We observe, also, that the aspiration for what is according to Nature is so far from being an obvious ethical object, that the ancient Christians regarded the natural as something leading to evil. The ancient Greeks, on the other hand, premised an agreement of the two; and so it came to pass that the former held a pessimistic and the latter an optimistic view of the world. But the Greeks did not believe in the natural because it was natural, but because they thought it good; as the Christians disbelieved in it because it appeared bad to them, and seemed to contradict their moral convictions.

We are glad to learn from the evolutionist all he can tell us of the nature of things, and of the means of reaching the object sought after by us. Of this object, however, we do not learn from a natural history of the objective world, but from the study of our own hearts. It is, therefore, self-evident that the utilitarian or the ethicist, who regards the highest general good as the chief moral standard, will make use of all knowledge that can cast light on the way to his end. Consequently, he will certainly avail himself of all the facts of biology and sociology that are of importance in regard to it.

Existence is the condition of happiness. If the happiness of millions of present and future living men is to be assured, then their exist-

ence must be assured first of all things. Everything, therefore, that is important for the most prolonged existence of the greatest number is also important for the greatest happiness of the greatest number. The utilitarian will utilize all that the evolutionist can tell him—and one thing more.

The evolutionist will tell him that there is a correlation, on one side, between disagreeable and destructive, and on the other side between pleasurable and advantageous action; that the "useful," in the sense of the pleasurable, nearly agrees with the useful in the sense of the life-maintaining; and that there is a close connection between health and happiness and between disease and unhappiness. While this correlation is far from being perfect, it is, nevertheless, true that a more certain road to happiness lies through maintaining or improving the health than through a direct striving after a maximum of pleasure. The same rule prevails in society. The sound health of society must be the practical end through reaching which alone the real prosperity of society can be attained.

The truth that health is a fundamental condition of happiness has, indeed, not been unknown to any ethicist; that pattern of ancient cheerfulness, the philosopher Epicurus, is an emphatic reminder of this fact. And that the care of one's own health is enjoined also through regard for others, and that the so-called duties toward one's self are really duties toward others, and for that reason only duties, is likewise a doctrine that did not have first to be learned from Darwin and Spencer. But we have to thank Spencer for having adduced, in his exposition of the facts of transmission, so potent evidence of this truth, that no such dictum upon it as Schopenhauer has uttered will ever again be possible. While, however, he has performed the service of defining the physical conditions of happiness with greater emphasis than any of his predecessors, it does not follow that the utilitarian method founded by Bentham will have to be given up. Evolutionist writers have reminded us that too little attention has been paid to health in discipline and in public instruction. This is too true, but it is not in consequence of the application of utilitarian but of non-utilitarian precepts. And if it has been declared to be one of the results of the doctrine of a correlation between species-maintaining and pleasure-bringing action that family happiness is the highest human happiness, that is only a confirmation of a view expressed long ago by utilitarian ethicists, as appeared most plainly a hundred years ago (1785) in Paley's "Principles of Moral and Political Philosophy."

If, however, by the phrase, "health of society," something else is understood than a society consisting of healthy individuals, then the word "health" is only a metaphor, and one the sense of which is not clear; and to put this metaphor in the place of the principle of the happiness of the whole can not be regarded as an improvement. If Bentham should return now, he would have to censure the evolutionist

ethics in no slight measure for its vague generalities and empty declamations, and its playing with phrases, and to combat its lack of circumspection. The evolutionists have joined generally with the utilitarians, but they are not practical ethicists. They could hardly succeed in actually working with their principle in such a compass as Bentham worked with his.

We come now to consider what is the bearing of the Darwinian doctrine of the struggle for existence upon morals. The objection has been brought against this doctrine, in divers phrases and with a variety of statement, that it leads to extreme demoralization. It can not be denied that Darwin's designation of the principle discovered by him as the "struggle for existence" is not fortunate, and is a metaphor, indicating a conscious hostile contention between living beings, each seeking the other's destruction, that has no real existence as such. And it will not be disputed that Darwin has been led into errors similar to those embodied in the theory of Malthus; or that great mischief has been done by the use of the phrase "struggle for existence" by persons who have never learned the A B C of ethics, but have still believed themselves called to offer their crudities to the public. But those mistakes are not to be alleged against the principle as such.

The principle of the natural selection of those beings whose modifications best adapt them to the conditions of their life is in the first place only an expression of that which has been, not of that which is to be. It is a law of Nature, not of morals. We are subject to this natural law of organic life, just as we are subject to the law of gravitation, or of the persistence of force, wholly without regard to our will. Natural selection is an agent which has operated as the general regulator of life upon the actual constitution of what is now existing in the organic world. It is the universal natural force that also regulates human life. And what do we see in human life? A fearful amount of moral and physical evil which is not prevented, but rather in part begotten by that regulator. We make it our task to contend incessantly by our premeditated action against that evil, while we regard the world, which is here without our assistance, not as the best possible, but as something which we must labor to improve and make more rational. What happens through the operation of the universal forces of Nature can not be a moral rule for us; for those forces produce also everything that is bad. This regulating principle implies that the being which possesses the most advantageous constitution, that is, which is best adapted to the conditions of its existence, has the best chances to maintain itself and to increase; and it applies to human beings as to all others. The fittest, or best adapted, survive. We have to distinguish among the life-conditions of man, or in his environment, between the physical and the social factors; the former regulating in general his physical, the latter his moral constitution.

What, now, is the moral constitution which enables the individual

endowed with it to maintain himself? The principle of natural selection is not contradicted by any fact in the history of mankind. The determination of what of its members shall survive is an affair of the particular constitution of a society. There are, as Everett * has remarked, different kinds and degrees of immorality which are always important to the result. A certain degree of honor, according to the proverb, is required for a man to preserve his social standing in a society of thieves. But, besides the avoidance of flagrant violations of the social contract, there is nothing which is universally and always debarred by the demands of the social environment. The man who was fitted to succeed in the early days of the Roman Republic would have failed in the later age of the empire; and one whom the social elements of the empire lifted up would have fared badly in the time of the republic. Indeed, societies in which the highest and noblest moral attributes are a passport to success are very rare. The "fittest" in the moral sense, and the "fittest" in the sense of Darwinism, are not often the same.

And is this the last word that is to be said for Darwinism in its relation to morals? Is the judgment that the moral best and the fittest in the Darwinian sense are often not the same, of unconditioned effect? We believe not.

The principle of natural selection regulates not only the life of individuals; it rules also over the lives of generations and of peoples. It may, indeed, happen to be the means of success in some one commonwealth to practice the religion of £ *s. d.* It may be that in a particular society selfishness, cunning, trickery, overbearing violence or fawning subserviency, and moral cowardice, or high living and ostentation, will give good chances for getting on; men of such characters may have, in some states, the best opportunity to raise themselves and their families, while one who despises injustice, lying, and hypocrisy, will have to go to the wall. But there is, nevertheless, as Matthew Arnold says, "an eternal power, not ourselves, that makes for righteousness." Characteristics, it is true, are transmitted; but not in the same combinations as they existed in the father or the mother; immoral characteristics, like those we have named, never in that which is adapted to insure success in a certain constitution of society. If we allow, by transmission or by training, some other peculiar quality to enter into the composition of the character, or if we let a certain quality be lost, then that "lucky balance" that brought success will be destroyed. The chances that the posterity of men possessing such traits of character as we have sketched will maintain themselves long, that they will not, sooner or later, fail, in consequence of collisions with the "physical, legal, or social sanction," with the laws of health or of the state, or with the demands of society, are not very great.

But "the eternal power, not ourselves, that makes for righteous-

* C. C. Everett, in "Unitarian Review," October, 1878; "The New Ethics."

ness," asserts itself in a still more imposing manner. We have hitherto considered only the lives of individuals and of single generations, but we must also regard the lives of peoples. It is manifest in this collective life, in a vastly higher measure than in individual life, that "the wages of sin is death." As Everett has remarked, again, one society may favor the growth of righteousness and honor, another that of knavery and hypocrisy. In one, drunkenness and sensuality, and similar vices, may cause a man to sink to the lowest circles of society; in another, they may raise him till he reaches the highest. But here, at last, we have a principle, to which these social conditions are themselves responsible. The one society will develop one type of character, the other a different one; but according to the type of character which it favors will it stand or fall. In this we find in the facts of history a confirmation of the fundamental difference between right and wrong. What we call justice is the only enduring basis on which society can rest. The nations that do wrong and despise justice, which lose themselves in sensual intoxication, are at last broken up, and a purer, stronger, and less depraved race takes their place.

If the opinion comes to prevail in a society that the struggle for existence justifies or demands a reckless pursuit of one's own interests, the oppression and ruin of the weak by the strong, the destruction of misery by destroying the miserable, the extirpation of the voice of compassion, which protests within us against such a course; if physical strength and refined cunning and selfishness are carefully cherished as the highest ideal, then the days of that commonwealth are numbered, for it has worked for its own dissolution by authorizing a "strife of all against all," which, true to its precepts, may come in at any moment when a community of interests may not be present. Let periods of want and danger, or of war, ensue, and we shall see what will be the fate of a society in which patriotism, devotion, ideal standards, and regard for truth and justice have been objects of ridicule.

All positive human authorities are subject to the authority of life-conditions. If they will not adapt themselves to the nature of things when they deal with the bases of social life, their enterprises will at last be shattered under the might of that authority.

Two elements, according to Everett, have contributed more than all else to the success of men in the conflict with animals, and of civilized men in contending with barbarous. One of these elements is knowledge, or the power of thought, the other is the force of the social impulse. Ideas on the one side, a self-forgetting resignation on the other, are what have given the victory to the higher races. Whatever restricts the course of either mental or moral development strikes the hardest possible blow against the stability of the social organism.

The distinction between right and wrong, to use an expression of John Fiske's, has its roots in the deepest foundations of the universe. The cosmical power of natural selection is not against, but for, morals.

It sanctions the most exalted ethical ideals, such as the choicest minds have conceived. It is a judgment-power, because it permits only that which is right and perfect to endure, and lets the unjust, the base, and the evil perish.

The knowledge that this world-power supports virtue, and contributes its part in elevating the moral nature, will inspire the moralist in his efforts in behalf of the good, and in his contention against the bad. But we must be careful not to mistake the true significance of this law. There is arising in the newer evolutionist literature a kind of fatalist optimism or optimistic fatalism, the effects of which may be no less disastrous than those of an undiscriminating pessimism. If natural selection is to select the good, then the good must already be there. It does not contradict this principle, that the human race will die out as other species have died out; but it follows directly from the principle that the race must die out if it becomes bad. Not without us, but through us, through our volition, conscious of that purpose, will the continuous development go on. In our day, says Salter, in his "Religion of Morals," evolution is sometimes regarded as if it was something outside of us and above us, and we had only to wait on its motion. But evolution operates through you and me. It is only an abstract name for the course which your energy and mine and that of other beings take. It is for better or for worse, according as we are better or worse. It goes on rapidly or creeps along painfully, according as our thoughts are quick or slow and dead. It is not enough to perceive that the bad will at last perish and the good persist. We must wish it to be the good that will triumph. It is still true that the sources of history are in us. The result of these considerations must be a heightening of the feeling of responsibility.—*Translated for the Popular Science Monthly from the Deutsche Rundschau.*

MOTHS AND MOTH-CATCHERS.

By AUGUSTUS R. GROTE, A. M.

II.

TO understand the way in which our North American moths are distributed (and by North American we mean the territory north of Mexico and the West Indies), we must study the physical geography of the continent. There is a perfect host of species and individuals, which depend on special kinds of plants, for the most part, and their diffusion is, of course, limited by the area of the plant upon which their caterpillars subsist. But the greater bulk of the species are not confined in their young stage to one sort of plant, while, from their activity, these flying flowers, the moths, range farther than the more slowly traveling blossoms whose honey they extract.

If we take a map giving a bird's-eye view of the continent, with the elevations marked, we can understand the problem better. Ranges of mountains obstruct, valleys and river-channels assist, the dispersion of moths. They travel on the wings of the wind, and an important factor is the prevailing seasonal direction of the air-currents. There is in North America a summer migration of many species from the South to the North, so that, toward the autumn, several tropical kinds have crept up along the coast, or inland, up the valley of the Mississippi. The "cotton-worm moth," which, in its caterpillar state, inflicts great damage at times upon the plantations, is a case in point. Individual specimens or flocks of other moths, such as the "great eye-spot" (*Erebus odora*), the "blue and green hawk" (*Argeus labruscæ*), visit us yearly, coming up from the West Indies. They die out in the winter here, and leave no progeny behind them to continue the species in our high latitudes.

Rivers assist in the dispersion of insects, and, in a less degree, perhaps, the particular insects we are here discussing. Nevertheless, upon leaves and sticks the eggs of moths are floated on the current, while the commerce of the water-routes brings the cocoons with the vegetables and fruits which it carries from place to place in boats and ships.

A bird's-eye view of our continent shows us the elevations of the Rocky Mountains and parallel spurs in the West, and the Alleghanies in the East. Mountain-ranges stand in the way of the spreading of moths, which perish in the cold atmosphere and the storms which gather about the rocky summits. Our faunæ can be understood by studying the formation of the land in this way. Over the vast plain east of Colorado the same kinds of moths generally prevail. The valleys in the West, on the other hand, contain a majority of peculiar species or kinds, often more local than in the East. In New York we are cut off, again, by the Alleghanies from many species which are plentiful in Ohio and Indiana. Our tropical wanderers come to us up and along the coast. I have met, sailing on the Gulf Stream, flights of moths, mostly of a few kinds, which fell on the rigging and sides of the vessel in great numbers. In the autumn, on Staten Island, I have captured specimens whose true home was Cuba and Jamaica. Although smaller faunæ, or limits of particular species, are traced by naturalists, our mountain-ranges are the best general guide as to the changes in the sorts of moths which we may expect. From Ohio to Louisiana we meet much the same kind of moths, with a difference in the rarity of certain species, and in the presence of others dependent on particular kinds of plants. But, when we get into the valleys of the Rocky Mountains, we shall have taken leave of the most of our dusty-winged Eastern friends. Some kinds take the voyage with us completely across the continent, but these are comparatively few in number, and are sometimes almost cosmopolitan.

So true is it that one branch of a subject leads to quite different

questions and to matters apparently foreign to the immediate inquiry, that here the subject of the range of North American moths leads us into myth and poetry. For, in finding out that we have species of moths which are found in other continents, the question arises at once, How did they get here? They could not fly over from Europe, nor could they now cross Behring Strait, with the Arctic climate there existing. Imaginative persons have supposed a submerged Atlantic Continent, which bridged the chasm in a remote geological period. The myth of the Atlantis has been recently furbished up under the facts supplied by the deep-sea soundings of the English steamer Challenger, and the discovery of a plateau at the bottom of the ocean, between North America and Europe. But, if it ever existed, it probably did so at a time before the ancestors of our present moths came into being.

For a moment, let us leave this matter and look at the question of the affinities of our moths. I have shown, in the "American Journal of Science and Arts," the detailed characters of one family of our moths, the *Sphingidæ*, and what is true of them is true generally. Our moths, in regard to their structural relationship with the moths of the world, fall into three main categories: 1. Those which are peculiar to North America. 2. Those which have their nearest allies in South or tropical America. 3. Those which have their nearest allies in Europe or Northern Asia.

With these last we have here to deal, and to account for their presence with us. This class falls into two main groups—those which are absolutely the same, and those which differ more or less, but clearly reveal their common ancestry. But there exists in these respects every gradation. Some differ so little that there is much dispute as to whether they constitute different "species," and some, again, only differ perceptibly in certain stages. Others differ a little throughout in all stages, and form what are called "representative species." So, far off in Arizona, I have found a species (*Copimamestra occidenta*) which "represents" a common European species (*Copimamestra brassicæ*). What is this little moth, with its big name, doing in Arizona, and how did it get there? With regard to those kinds which are absolutely identical in America and Europe, some have evidently come over through commerce in historic times. We have found out almost the particular voyage which brought the "white-cabbage butterfly" from England to Quebec, whence the insect has spread over the New England and Middle States, to the great injury of our market-gardeners and cabbage-growers. But of some the distribution is such that this can not be the explanation of their presence here. Of others it may be doubtful. I am inclined to believe that another cabbage-insect, the moth called *Pluria ni*, has been brought over in this manner. But how about our Arizonian *Copimamestra?*

We shall have to leave entomology and go into geology to answer

this question. Formerly there was a warm climate in the north during the Tertiary period. This was a certain measurable time ago, when the circumpolar regions had a warm average temperature, with no winter, and the moths of the period were then substantially the same species from Norway across Siberia to Greenland. During this happy time—happy, at least, so far as weather was concerned—we must imagine that no impediment existed to the migrations of animals across what is now Behring Strait. It is probable, even, that the Tertiary epoch, as it witnessed the first appearance of man, saw his first wanderings in North America. He, too, came from Asia by way of the north and Behring Strait. Evolution had performed surprising work in the mean while with one branch of the human family, members of which, landing from Scandinavian or Spanish ships, met, upon American soil, the descendants of a migration from Asia to America in a former geological period, and to the east! At the close of this Tertiary period of the earth's history, cold and snow and ice set in; the long winter of the ages made its appearance in the shape of the Glacial epoch. The circumpolar moths, whose more humble fortunes we must be content here alone to follow, were forced southward gradually by the change in climate which gathered its frigid strength in the north. The European, Asiatic, and American faunæ then became separated, the latter the most completely, and by barriers both of ice and ocean. The American species of moths, which formerly lived upon the shores of the Arctic Ocean, were gradually forced down, year by year, until they reached Mexico, or the elevated portions of the Southern States. When the glaciers subsided, and the floods of ice which had submerged the continents gradually melted and slowly drained away, the moths, much changed by the long conflict, also retraced their steps northward. As marks of the retreat and advance, colonies of moths were left on the mountains to tell of the flood. At this time our "Western clawed cutworm" (*Copimamestra occidenta*) had been long separated from its present European brothers, and the differences by which we now recognize the two species as distinct had become slowly established through a long series of succeeding generations. What miles of land and sea separate the two to-day! The descendants of a common circumpolar species find themselves partly in Germany, partly in Arizona, and the Southwestern territory of the United States!

Let us turn back to the other theory, that of a submerged Atlantic Continent. Whatever may be finally proved from geology as to the existence of such an Atlantic bridge, it is clear that the myth of the Atlantis must be separated from such facts, as being of much more recent origin. Primitive man existed æons before the notions which were worked into the poetic and semi-historical myth of the Hesperides and Atlantides. The setting sun was followed by human eyes for untold ages, as it bathed itself in the golden flush of evening, and was

at last whelmed by the waters which were held to surround the supposed circular flat earth. The sun was the golden apple of the garden of the Hesperides, the Golden Fleece after which Jason sailed. The poet transformed the primitive notions into charming myths, which probably had their origin from the observation of low-lying clouds floating, like islands, in a sun-flushed western sky. In this region of imagination and romance it is, perhaps, better—at any rate, it is excusable—to abandon prose and take to verse. So we shall quote a modern rhymer for the explanation of "the Atlantis":

The western sky is all ablaze,
  And, floating on that golden sea,
The clouds, like islands in a maze,
  Blest dwelling-places seem to be.

When first this sight was viewed by man,
  He thought the earth was flat, not round;
That all about its rim there ran
  An ocean which the land did bound.

The poet in those early days
  Immortalized the sun-flushed seas;
He peopled those far slopes and bays,
  And called the isles Atlantides.

And so the legend grew until
  The clouds in evening's dreamy light,
With which the poet showed his skill,
  Had vanished from the mental sight;

Instead, the story true appeared,
  And every sailor did his best,
While straight from port the vessels steered
  For those far islands in the west.

But none returned: of all who went,
  Who sight of those fair islands caught,
Through the white waves the tempest sent
  The barks which shattered home were brought.

And some returned no more—but these
  Were fabled to have reached the strand,
Where, anchored in luxurious ease,
  Their ships will never leave the land.

The crews lie on these sunny slopes,
  Purple with fruit, with vintage blest;
The ships are held by flowery ropes
  In sleepy bays content to rest.

The poet steps into his boat,
  The sunset makes his starting fair;
Through the long night with Death he'll float,
  And in the morning he'll be there.

The study of the geographical distribution of moths has led us a long way back in the history of our own race, to that East whence art and science sprang. There is only one other fact to be briefly mentioned here, and that is the discovery by Louis Agassiz, who accomplished so much toward an understanding of our entire fauna, of a tropical colony of moths inhabiting the southern extremity of the Peninsula of Florida. I have examined the specimens brought thence, now in the Museum at Cambridge. Standing in the way of the south winds and the Gulf Stream, Florida receives constant accessions to its tropical colony of insects. Not a few of the Florida moths seem to have changed a little, and the probability is that here also we may have to do with descendants of a very ancient colonization. Our continent, in fact, has harbored many immigrants besides the Pilgrim Fathers, who are distinguished among these by their greater importance, and the results of their adventurous voyage.

The celebrated receipt of Mrs. Glass, which is of such general application and has served so many literary purposes, must be employed before we can place our specimens of moths in the cabinet. And, indeed, everything depends upon the catching of them, and their appearance after being caught. The scales and the little fine fringes which edge the wings are but delicately fastened to the membrane of the wing itself, and are lost with the lightest rubbing. Some species can never be captured on the wing in a really perfect condition. When the "bee-hawks" (*Hemaris* sp.) emerge from the chrysalis, there is a dusting of fine scales over the glassy portions of the wings, which is scattered by the first fluttering flight of the insect:

"Like gold motes in the air it flies."

Again, several moths are ornamented with patches of looser and bright-colored scales which are readily lost, the specimens still appearing fresh after they have vanished. Thus the "dark-red underwing" (*Catocala cara*) has the fore-wings adorned with spots of a greenish hue when it leaves the pupa, but they are apt to fall and the wings then appear all of a dark-brown. Not knowing this, the fresh specimens have been described as a new variety, by an enterprising and unfortunately somewhat critical writer, under the name *Carissima*.

We have the choice of pursuing our entomological prey in each of its stages of growth—of eggs, caterpillar, chrysalis, or moth. If we gather them in either of the first three states, we have to nurse them until they are brought to the last, and, since in this way we can always obtain bright examples, it is much preferred by moth-fanciers. It is, indeed, the only way to obtain adequate information about these insects, and, as they are usually brought through them all with less difficulty than the other insects in captivity, the breeding of moths becomes an alluring and profitable pursuit.

Egg-hunting is the least remunerating way of procuring moths,

from the difficulty of detecting the little objects, like pins' heads, upon the leaves and flowers where they are laid. Eggs are usually stuck fast to the under side of the more tender leaves of the plant, though this rule is not invariable, either as to position or choice of leaf. Usually the outer leaves are chosen, and by turning them up with care and running the eye over them, and especially down the midrib, the little whitish or greenish egg may be seen. It requires good eyes and much patience, but I have found the eggs of about twenty species in this way: those of the "bee-hawk" on honeysuckle, of the "Cecropia" on apple and lilac bushes, the "white-lined-hawk" on purslane, etc. The "lackey-moths" (*Clisiocampa*) and the "deer-moths" (*Hemileuca*) lay their eggs in circular patches around the smaller branches of fruit and oak trees. The eggs are found sometimes to have been stung by a little clear-winged fly, and out of these, instead of the expected caterpillar, only the tiny but full-grown parasite escapes.

The rearing of larvæ or caterpillars may be conducted on a variety of plans. I have found an upright box, with glass in front, and perforated zinc for the sides, or fine wire netting and a solid door at back, by which the fresh food is introduced, very serviceable. A drawer at bottom is filled with fine washed sand, over which is placed a layer of garden-mold, and then a covering of moss. The food is placed in short water-bottles, to keep it fresh, and the caterpillars are placed on these. But, when a boy, I reared many species in an empty butter-tub, covered by common gauze. Almost all caterpillars may be handled with impunity. Some of them are ferocious-looking enough to inspire a fear of their biting powers, but they are unable to hurt us in this way. The caterpillars of the "hawk-moths" have a formidable-looking horn on the last segment or ring of the body. I have noticed that inexperienced persons often mistake the position of this horn; they regard it as being in front, whereas it is attached to the tail-end of the larva. There is nothing "poisonous" about any of these caterpillars, but two kinds cause a painful irritation to the skin when touched with the hand, by means of the fine hairs which are thus forced into the pores, and, the tips breaking off, cause fever and pain as from a bee-sting. These two are the odd-looking caterpillar of the "brown hag-moth" (*Empretia stimulea*), and the delicate-green caterpillar, with pink and white stripe on the side, of the "corn emperor" (*Hyperchivia so*). Other hairy caterpillars may also produce more or less discomfort when handled, but the frightful stories which circulate in the newspapers from time to time, of people being stung to death by the caterpillars they chanced upon, are all false. Caterpillars can not sting, for the simple reason that they have nothing to sting with, and when an injury of this kind has been really inflicted it will be found to have been occasioned by something other than a caterpillar.

Hunting for caterpillars is attended usually by more success than the seeking for eggs of moths. One can readily detect the presence of

these often unwelcome visitors by the damage they do to the treasures of the gardener and farmer. Many kinds feed in clusters, and make nests into which they retire in the daytime, separating usually before full grown and to make their cocoons. The larger species are all solitary, and some are the most beautiful objects one can wish to see. The caterpillar of the "imperial moth," which may be found on the horse-chestnut, tulip, and gum trees in Central Park every September, when it is full grown, is a thick, green worm, as long as the thumb, with four beautifully notched horns on the back, behind the head. Delicate hairs adorn the body, and the fleshy feet behind are ornamented by a design in black-and-white, looking like bead-work, and as if the creature wore Indian moccasins. In April and May we may find the larvæ of species which pass the winter in that state. One of our handsomest caterpillars is that of the "great Indian moth" (*Ecpautheria scribonia*), black, studded with bristles and with the incisions of the rings of the body marked in scarlet. I have fancied that this caterpillar is the one noted by the Indians, and sung of by Longfellow in "Hiawatha."

It is very interesting, no matter what the species is, to watch it through all its changes, and be rewarded finally by the moth disclosing all its fresh beauties before our eyes, as it hangs on the side of the breeding-cage. The caterpillars of the "hawk-moths," and many "owlet-moths," enter the ground to pupate; and for this purpose the sand and soil in the bottom of the breeding-cage must not be kept too dry, nor suffered to become hard. Those which do not go into the ground will transform within cocoons spun among the moss, or on the sides of the breeding-cage.

To collect the perfect moths, an empty quinine-bottle must be prepared by putting a few small lumps of cyanide of potassium on the bottom, and pouring on sufficient plaster of Paris to cover them perfectly. When the plaster is set, the fumes of the decomposing cyanide penetrate through the plaster, and the moth introduced into the bottle is almost instantly killed. Poison-bottles, so prepared, are indispensable to the collector, and they can be recommended on account of the speedy and probably painless death which they inflict. The objection to entomology is its apparent cruelty. I think that an unnecessary number of specimens are sometimes killed by the enthusiastic collector, but, after a little, this fault will be corrected by reflection and experience. When we recollect that insects are the main store of food to numberless birds and animals, besides falling a prey to each other, so that the greater proportion meet a violent death in any case, the comparatively small number which fall a sacrifice to the pleasure of the collector, or supply the studies of scientists, can not in reason be objected to. Our æsthetic pleasures are increased by the contemplation of the lovely colors and delicate patterns which adorn the wings of moths.

That man is feral, and a hunter by nature, is an obvious reflection, even when we step into the shop of an entomologist, such as Cooke's, in London. Nets, traps, and "fearsome gins" of all sorts and sizes meet the eye. Boxes, pins, dark-lanterns, in fact an array of implements too numerous to mention, are there displayed, and, whether we go a-hunting for game or for moths, the ingenuity of man has invented a large quantity of apparatus, by which the result may be obtained with the least exertion and the greatest certainty. Simplicity here as elsewhere is, after all, to be commended. A small folding-net which may be carried in the breast-pocket and afterward screwed to the end of a walking-cane, a poison-bottle, and a couple of boxes which may all be carried in the coat-pocket, are a sufficient outfit, and one with which great results in the moth line can be reached. The box for caterpillars should be of tin, and care must be exercised not to place too many together, since some kinds have strong cannibalistic tendencies and may devour each other before we get them safely home. But not only by day are moths captured. They fly readily to light in the evening, and the best results are obtained by spreading a bait, made of beer and molasses, with a paint-brush, on the trunks of trees standing free. In the spring and early summer this method of catching moths may be practiced with almost the certainty of taking many rarities. After this means the best plan is to watch the flowers which the moths frequent in the evening in search of natural sweets, and in which occupation we may fatally surprise them.

Having caught our moth in one way or another, it must be pinned and set, before placing it in the cabinet. In America the long German pins are used, especially manufactured for entomological purposes. The moth must be pinned directly through the center of the thorax, taking care to displace the scales as little as possible. Setting-boards are easily made by fastening two strips of soft pine-wood upon a thin board, near enough together to admit of the free passing of the body of the moth between them. They must be of several sizes, to correspond with the breadth of wing of the moths, which must be pinned with the body resting in the groove and the wings lying flat upon the strips. The board may be ruled across with lead-pencil, at different intervals, the lines serving as a guide to get the wings straight. With a bristle fastened to the end of a little stick, the front wings should be carried forward until their lower margin is about parallel with the hind edge of the thorax. They may be held in position by small three-cornered cardboard braces till all the wings are evenly placed, and then fastened down by strips of smooth paper, kept tightly in place by pins above and below the wings. It takes from a few days to a fortnight to properly dry the moths so that they can be placed in the cabinet.

Various and multiple are the store-boxes, implements, and "traps" of a moth-catcher. To describe them all would take a moderate-sized

hand-book. My experience is, that simplicity is the most necessary guide for the collector, whether in the field or closet. A few tools and some cork-lined boxes will accomplish a great deal in the hands of an expert, while the expensive paraphernalia of the novice will fail of adequate result. As a rule, the most pleasure and information are yielded to the student who gradually increases his stores from his own catching, who follows the moths into their retreats, and by his industry and pertinacity compels Nature to yield to him a measure of her secrets.

Long ago I remember catching moths one summer night in the country, back of Newburg, on the Hudson. What a lovely and perfect night it was! A sheen lay over the grass, and the field-daisies stood tall and pale and spectral in the moonlight. Their white flowers looked like silver crowns, waiting for some love-sick damsel to pluck and gather her fate from the number of their petals. They stood in silver and gold, without envying the yellow and brown daisies of the meadows which were hardly open yet. The air was traversed by leather-winged bats, also out after insects, and I felt convicted by being in their company. A pale-green moon-moth fluttered by the skirt of the dark wood, the long "tails" to her wings trailing like the court-dress of a queen. I stayed my hand and let her sweep by, hoping that those marauding bats might not espy her as she floated in the night-air, heavy with the scent of roses. For aught I saw, she escaped them, and the peril of having her white body devoured, her green wings clipped from her shoulders, falling idly, like the petals of dying flowers, upon the ground.

Painters have not yet learned all they can from the coloring of moths. Some moths are pale-pink and yellow, only these two colors, reminding one of apple-blossoms and yellow moonlight. I saw a panel of C. Colman's once, for the contrast of colors of which it seemed he must have studied the wings of moths. As the musician can use the songs of birds, so the painter may copy the colors of the moths for our greater pleasure and his own benefit. A great deal may be said of the unconscious schooling we get from Nature.

"All sorts and conditions of men" and not a few talented and accomplished women are among the American students and collectors of moths. Before the last quarter of a century, those who interested themselves in America with this department of our fauna were few, and those who published the results of their investigations might be counted on the fingers of one hand. Harris in Massachusetts, Fitch in New York, Kirtland in Ohio, Gosse in Canada, were the best known. Thomas Say, of Philadelphia, published two species in his "American Entomology." But since that time, Professor Packard, Professor Fernald, Mr. Henry Edwards, Mr. F. Pepper, Mr. Lintner, and a number of talented writers, have become familiar names to those interested in the subject in the pages of its literature. The "New York Entomo-

logical Club" publishes a monthly magazine, entirely devoted to Lepidoptera. The Buffalo Society of Natural Sciences has issued three handsome volumes chiefly devoted to studies on our moths. In Cambridge, where Harris lived and studied, a very useful journal—"Psyche"—appears, while in London, Canada, Mr. Saunders edits "The Canadian Entomologist" in monthly parts. The various State entomologists publish yearly reports, and the Department of the Interior has published valuable monographs and papers relating to our moths in the publications of the geological survey. The great work which has been done in the United States in science has helped also the increase of information upon this comparatively small branch of natural history. I should have mentioned the ladies first, but it is not out of politeness that the conscientious historian records the services to science of Mrs. Eliza Bridgham, of New York; Mrs. C. H. Fernald, of Orono, Maine; and Miss Mary Murtfeldt, of St. Louis, Missouri. Mrs. Bridgham's extensive collection, commenced under the eye of Agassiz himself, is a model of useful collecting for scientific purposes. The species are not represented by single individuals, but the varieties of each species, and a sufficient number of duplicates to allow of the study of the structure and changes, are all carefully placed and labeled. Years of patient and careful toil have their reward in the most interesting local collection, from a scientific stand-point, I have yet seen.

In Europe our moths have been described and studied by two French scientists, MM. Boisduval and Guenie. In Germany, Professor Zeller and Dr. Speyer, together with Herr Moeschler and the lamented and talented Viennese lepidopterist Julius Lederer, have published interesting studies upon our North American fauna. In England, the late Mr. Walker accomplished less satisfactory work in the precincts of the British Museum, and is now succeeded by Mr. Arthur G. Butler, whose work merits all praise. But our best incentive to the study of our moths has been afforded by the example of Lord Walsingham. It is ten years ago since his lordship visited the United States, where, unlike many of his countrymen who come to hunt buffalo, he went West to hunt moths. Lord Walsingham visited California and Oregon, and camped out like a true hunter. While his companions took the rifle, he handled the entomological net, and to such good effect that science has been the gainer by hundreds of new species, and a much clearer general knowledge of the subject than before existed. The delicate operation of setting his tiny captures, Lord Walsingham accomplished successfully even on horseback, as the camp was shifted from place to place—quite a feat, when it is recollected that the tiny specimens, many not a quarter of an inch in expanse of wing, require a steady hand and the most favorable conditions to be successfully prepared for the cabinet. This memorable trip of Lord Walsingham's had the result of directing the attention of our collectors to the rich-

ness of Western fields for moth-catching. Their cabinets soon presented new "beauties," vying with Indian and Brazilian species in varied colors and far surpassing them in general interest.

I said that "all sorts and conditions of men" were among those interested in forming collections of moths, and it may be inferred that there are queer specimens among the owners of the cabinets as well as in the drawers of the cabinets themselves. Moth-catching is a hobby, and, like other hobbies, it depends upon how it is ridden to pronounce upon its value from a social or scientific point of view. Some collectors amass their material from an apparent simple satisfaction in possessing rare or odd specimens. They have no appreciation of the bearing which the subject has upon general science, and no higher artistic interest in their possessions than the one that they have something no one else has got, and which it is difficult to obtain. A sort of purposeless mania seems to fall upon many of them, and they might as well get together a lot of old bottles or stones as moths. They deceive each other as to the locality for their rarities. I have even heard of one rabid collector, now happily deceased, who destroyed every specimen he had or could buy up of a certain rare exotic species, except one pair in his own collection, so that he could say he was the only one who had it! Another openly stated in an advertisement that he "coveted" certain specimens, which he offered to buy; thus, probably unintentionally, using a word which expressed his condition exactly, and in this way succeeding in breaking a commandment and exposing his state of mind at the same time.

While the "brethren of the net," as the moth-catchers are fond of styling themselves, are, generally speaking, a friendly and useful class, they necessarily include many who follow the occupation, but are yet not truly of them. From such the gentler student will soon turn away, sometimes not detecting them until he has suffered in purse and cabinet. Like other "confidence operators," they generally take in uninformed and young collectors, whose rarities are speedily transferred out of their keeping by the false statements and industrious letter-writing of these moth-poachers. They are the dark side of a picture which would be otherwise too bright and happy.

Among the figures of moth-catchers which have crossed my own path, I finally recall that of a kindly old gentleman, now no more, who for many years was a visitor to my humble study. His beardless, wrinkled face, framed in gray hair, had ever such a good and serene expression as betokened a mind which had caught its serenity from the countenance of Nature herself. I visited him in turn and not unfrequently, and I remember on one particular occasion that he showed me a new capture which he had made on Long Island, a new butterfly, not then described in the books. As he took it from the box and placed it on the table before him, pinned, dried, and set, in all its beauty, a little dog, which was his pet and companion, sprang at his

knee and with one blow of his paw broke the butterfly. To the old gentleman it was as to Sir Isaac Newton—the loss was great, and the shock must have been intense. Although I had hardly seen the specimen, I was profoundly affected by the mischance. But he neither struck the dog nor spoke loudly. With a trembling hand and flushed face he set to work at once to gather up carefully the disjointed wings of his specimen, which was happily accomplished, and, with a little gum and much patient dexterity, the damage which seemed at first irreparable was remedied. It taught me a lesson I have never since forgotten. The butterfly was the rare *Papilio Calverleyi*, of which up to the present time but one other specimen has been found. I have now new faith in that old story, from having witnessed a similar occurrence, and fresh belief in the goodness of that human nature which science and its pursuit often tend to strengthen and confirm.

HYGIENE OF THE AGED.

By L. H. WATSON, M. D.

DIFFERENT epochs in life are marked by the frequency or infrequency of certain morbid phenomena constituting that departure from the normal standard of health which we denominate disease.

What is life? is the unanswerable question the human race has ever sought to solve. Bichat called it "the sum of the functions by which death is resisted." Physiologists of the present day offer little more that is satisfactory in their definitions, calling it "the aggregate of the phenomena peculiar to living organisms." The inscrutable mystery which surrounds the principle of vitality renders any attempt at definition illogical and unsatisfactory. We have to deal with the phenomena of life, and the functions through which these phenomena are manifested. In the child we have an exuberance of life. Manhood is the period of repose; waste and repair seem to neutralize each other; and calmness, deliberation, and quietude prevail.

With old age come disturbance, waste without repair, destruction without building up, action without reaction, decay and death. These phases of animal life are constantly repeating themselves. In discussing the diseases of old age, we have to deal with the phenomena of life, the perversion of functions which have hitherto counterbalanced each other. The prime of manhood and stability is passed; internal resistance now fails to maintain itself against external force. Nutritive action does not respond to the demand to renew effete material. The equilibrium being destroyed, decay and the products of decomposition become the most important factors in the study of the diseases which now threaten to disintegrate this hitherto self-sustaining system.

It will easily be seen that the diseases which disturb the formerly evenly balanced organism tend toward what pathologists call destructive metamorphosis. Blood-changes, tissue-changes, and secretory changes, are subjecting us to constantly varying standards of health. How to maintain the equipoise as long as possible, and prevent the too rapid decline of the vital forces, as well as to suggest measures—when care and forethought can ward off the blow—is the province of the thoughtful medical man.

Threescore years and ten should certainly be reached by most of those who attain adult age, provided no inherited taint weakens the vital forces. It is difficult to determine the exact period of life at which the decline commences. In fact, there can be no absolute standard from which we can predict with unvarying certainty the gradual failure of the physical powers. Some seem to inherit a vitality which almost defies the ravages of time; but, although they are apparently in the full vigor of life, close scrutiny rarely fails to detect the fact that the scale is tipping downward. We do not grow old in a night, although we often make the remark that So-and-so has grown ten years older since the occurrence of some great grief, or some disastrous reverse in business. The eye-sight gets poorer, the hair and beard grayer and thinner; the form is more bent, the walk more uncertain, the *arcus senilis* appears in the cornea. After all, this is not old age; these are all warnings, but the heart is still warm, the eye still bright, the muscles still firm. The world looks as fair and inviting as it did in early manhood or womanhood—a little larger print to read, a smoother road to walk on, a few more flannels at night, and a little less labor during the day, with perhaps a greater disposition toward quiet, a greater fondness for home-life, and a disinclination to encourage the enthusiasms which time and experience have so often proved to them to be illusive.

We are to consider the physiological and pathological conditions arising during this epoch of life. Many of these are characteristic, and do not earlier manifest themselves. We have many works upon the diseases of children and adult life, but almost none pertaining to the diseases incident to age. And yet they are peculiar. The pneumonia of a child is not the pneumonia of an aged person. Slight ailments, unobserved or disregarded in the adult, become positive disease in advanced life. Our acute fevers, inflammations, fluxes, etc., are not met with among the aged.

Congestions, chronic inflammations, tumors of the brain, paralysis, rupture of blood-vessels, enlargement of the heart, chronic bronchial affections, dropsical effusions, indigestion, diseases of kidneys and bladder, especially the latter, cancers, etc., are what the physician is most often called upon to prescribe for in old people. Aside from actual disease, the conduct of the life of elderly persons is to be studied and observed. Ordinarily old age brings with it, or should,

a certain degree of leisure and immunity from the distressing anxieties which vex and worry the lives of men actively engaged in business. The danger of sickness from exposure, as far as the *liability* to exposure is concerned, and the danger arising from accidents are lessened; old people are careful, and warily thrust themselves into danger. Calmness, quietness, and a regular habit of life, succeed to confusion, activity, and an indulgent and irregular method of living. Life wanes, the descent is easy and gradual, a peg is lost here and a prop there, the sympathies become blunted, the intellect chilled, the senses lose their acuteness, and "the play is played out." What more delightful spectacle than an aged person in full possession of all his faculties, enjoying life with the zest of manhood's prime, appreciative of the pleasures of the table, the society of friends, the charm of music, and the intellectual feast that a good book presents to him!

Hufeland, in his "Art of prolonging Life," advises old people to eat sparingly. There is a great difference between a "*gourmet*" or "*gourmand*" and a glutton. The pleasures of eating dependent upon the sense of taste, when eye-sight and hearing are daily becoming more and more impaired, the possession of leisure in which to cultivate their gastronomic talents, as well as the quiet necessary for the performance of the digestive act, combined with the necessity for careful nourishment, prohibit old people from yielding to any mistaken notion that, because they are old, food is of little consequence to them, and that the ordinary rules governing assimilation and nutrition do not hold in their case.

A great deal of the immunity of old people from sickness will depend upon their power of digestion and assimilation.

Food and drink should be partaken of sparingly, and at proper intervals: an overloaded stomach, or a stomach filled with badly cooked food, or food taken at an improper time, will occasion much distress to an old person. At the same time, it may lay the foundation for disease which will cut short a hitherto robust old age.

If actual pain and danger do not follow this gorging, it will probably entail loss of sleep, and consequent exhaustion, all of which we seek to shield the old from, as we do the child.

In the normal act of digestion, the consciousness of that act is wanting. Most persons engaged in active life fail to give the proper amount of time to eating and digestion; for this natural and physiological action to be performed with the ease and perfection of detail which Nature, in her arrangement of the means for such an end, intended, deliberation must accompany the eating, and rest of mind and body the digestion of food. Haste when eating, and activity, bodily or mental, during the digestive process, are fatal to the object for which food is taken. It is only in old age (I refer particularly to America), now, that that leisure which is indispensable to the proper performance of digestion is obtained, and yet, when, after years of toil, we

perchance through the inheritance of a resisting power which has enabled us to arrive at sixty years of age, and upward, find the *time* to rest, our teeth are gone, our stomach, from constant action, is unable to act with that promptness and energy which early in life enabled us to digest food on the run, as it were. Then the physician is called upon to encourage, stimulate, and prop up by his art, Nature's waning forces.

The manifestations of dyspepsia in the aged do not vary materially from those of adults, but the causes are somewhat different; the treatment is conceived on a plan based on the age and life-long habits of the patient. An aged stomach is not an active stomach. Atony characterizes its functional action. Acid digestion, gastric catarrh, and flatulency, are the leading forms of dyspepsia of the aged. Old people have not in general what we call a healthy appetite. One well-known writer has said that they eat because no other interesting occupation is afforded their senses. This may be true of the *very* aged, and it undoubtedly is a fact that most people of eighty years and upward find as much pleasure in eating as in almost any other occupation left them. The appetite is often lost when no disease can be detected. There is loss of the sense of taste, and even several days without food does not provoke hunger. In another form, the breath is somewhat offensive, the tongue furred, when in the former case it was clean.

Fisher tells us that, if this continues, it leads to senile marasmus or atrophy of the aged. Some old people suffer from a difficulty in swallowing, which seems to be the result of a partial paralysis of the throat; the pharynx does not respond to the stimulus of food as it passes over it. Solids pass more easily than liquids. Deglutition is more difficult in an upright than in a horizontal position. Fisher speaks of the case of a man sixty years of age who swallowed soft and mucilaginous preparations with great difficulty, but warm food, salty or irritating substances gave little trouble. Day has noticed the same fact, and observes that irritating or highly seasoned foods were the only ones swallowed easily. Canstatt thinks that the abuse of tea and coffee leads to the development of this state, which he says is very common in Holland.

Old people are subject to accumulations of gas in the intestinal tract, which not only occasion distress from over-distention of the stomach, causing pressure upward upon the diaphragm, and consequent interference with the heart's action, especially when lying down, but also from its passage downward into the bowels.

Diarrhœa is one of the consequences of dyspepsia, and it is not unusual to find old people who have several movements of the bowels daily, without any of the exhaustion attendant upon ordinary diarrhœas. Another remarkable fact is, that we find, even in very old people, a diarrhœa which would naturally seem to weaken and prostrate even a strong man, but the effects of which are not noticed until

suddenly we learn that death has taken place. Overfeeding is a frequent cause of these senile diarrhœas. The pressure of undigested food in the intestinal canal is followed by a sudden purging, without pain, but exceedingly rebellious and difficult to conquer. Before treating of the methods of cure for dyspepsia and its accompaniments, such as loss of appetite, difficulty in swallowing, flatuence, constipation, etc., there remains to be studied the food suitable for old people, the quantity to be eaten, and the time for eating.

It would be useless to present a dietary list to which one should be strictly confined. A long life of indulgence in eating and drinking, as well as diversity of taste, would preclude any attempt at regulating the diet of healthy elderly people. To those who have arrived at an advanced age without any form of indigestion, I would suggest a cup of coffee and a slice of dry toast before rising in the morning. The reason why this should be served while one is yet in bed is, that very old people, even when perfectly well, are often subject to a slight faintness and nervous tremor before rising, and the exertion necessary to dress often leaves them too faint to eat. It takes but a few moments to prepare it, and, as old people like to rise early, it is usually an hour or two before the family are prepared for the morning meal.

A light luncheon at noon, and dinner not later than five or six o'clock. If the dinner is taken at noon, and supper at six o'clock, it will be found to suit the habits of the aged better in one way, as old people love to retire early. In most countries, among civilized nations, the practice of crowding three meals into the twelve hours or more of daylight has grown to be such a habit that it seems a heresy to suggest eating when hungry, day or night; nevertheless, I would suggest to the healthy and not *too* aged person to forget the "bugbear" of "not eating before retiring," which compels many a person—otherwise disposed—to pass ten or twelve hours with the stomach in a collapsed condition, while during the other twelve it is constantly distended with food. I would say to the aged, eat sparingly and eat frequently. Let your food be light, and easily digestible, but eat when hungry, whether it be twelve o'clock at noon or twelve o'clock at night. Aged people are light sleepers, and often wake up during the night with an intense craving for food, and a good plan is to have a cup of bouillon and a cracker on a stand near the bed. The broth can be readily heated by an alcohol lamp in five minutes. This simple habit will often procure hours of uninterrupted slumber, which would otherwise be passed in restless longing for daylight and breakfast.

I have said, eat sparingly and frequently; eat sparingly, because the digestive action is not so strong as in earlier life, nor is the demand for large quantities of food so urgent. Eat frequently, for several reasons. The digestive organs are not then burdened with large quantities of food, and dispose of it with greater ease. A moderate amount of food in the stomach gives a feeling of comfort and quiet to a person

whose sole occupation may be a little reading or knitting, or even nothing at all, when extreme age is reached.

The kind of food to be eaten varies with the condition: if the old person needs building up, the more nutritive foods, that is, those containing the greatest amount of nourishment to a given volume, the greatest proportion of assimilative matter; if, on the contrary, it is necessary to encourage the digestive action, we select stimulating food. In this connection I shall quote from an eminent French authority: "As age advances, not only is one able to bear with impunity food which is piquant, pungent, and more exciting, but the use of these latter foods is necessary to the physiological conditions acquired by the 'organs of digestion.'

"This alimentation becomes especially necessary to individuals whom residence in great cities, sedentary life, and confining work separate in a great measure from the natural conditions of life, found in free air and bodily exercise." With regard to the use of wines or liquor by the aged, I would say, if there is a proper time in the life of a man when he should use stimulating drinks, that time is when he has arrived at a good old age.

A glass of sherry or burgundy during dinner often aids digestion wonderfully. When the tongue is pale, and the desire for food absent, a "nip" of brandy will stimulate the stomach into secreting properly. This condition of atony or sluggishness of action is not at all unusual. A glass of milk-punch at night often goes, as a very good and exceedingly temperate old lady once said to me, "to the right spot." Coffee is a natural drink for the aged. Its mildly stimulating, soothing qualities directly indicate it as a beverage for the old. Gasparin tells us that "coffee has the property of rendering the elements of the body more stable, and thus, if not affording nourishment, it diminishes the waste going on."

The origin of many dyspepsias in the old will be found in the lack of the proper means for the complete mastication of their food. The loss of their teeth, and the neglect to replace that loss with artificial ones until a dyspepsia is established, will often entail a long train of ills. A set of false teeth will sometimes remove dyspeptic troubles of long standing. The teeth with metal plates (platinum or gold), although more expensive than rubber or celluloid, are to be preferred. Mastication must be well performed even if the food is not very solid. The one golden rule is to eat slowly.

Some old people have idiosyncrasies about certain foods, which must not be overlooked. Milk is one of the most easily digested of foods, on account of its various constituents, and can be taken when nothing else is permissible. Eggs, soft-boiled or raw, are easily digested. Oysters, fish, and lamb, follow in about the order named. Beef, mutton, and fowls, and wheaten bread, occupy about the same time in digestion. I have met with two forms of dyspepsia more frequently

than any others in prescribing for old people—the acid form, where there is an excess of acid found in the stomach, and the atonic form, where there is sluggish action of the mucous membrane of the stomach, and the time for digestion is greatly lengthened. In acid dyspepsia, Dr. Ringer recommends the use of glycerine, stating that an old gentleman, upon learning that glycerine prevented milk from turning sour, concluded that it would be just the thing to prevent "himself from turning sour." I have used glycerine combined with charcoal with considerable success in remedying this form of dyspepsia.

Dilute nitro-muriatic acid, a half-teaspoonful in a claret-glass of water, immediately after meals, breaking up the weaker acids and affording the natural acids of the stomach, is an exceedingly useful remedy. The atonic form of dyspepsia, combined with loss of appetite, requires quite a different treatment. The stomach is feeble, and needs stimulating; two or three grains of capsicum with one half-grain of aloes in a capsule will excite it to action; the constipation which often accompanies this form will be obviated. When there are accumulations of gas, charcoal tablets an hour or two after meals generally give great relief; but it is not a good plan to keep up their use permanently, as it tends somewhat toward constipation. Electricity is the great tonic for these debilitated, relaxed stomachs. The sympathetic nervous system is rehabilitated, and the most marvelous effects are often produced. The apathetic condition of the intestinal track is dissipated, the liver pours out its bile, and life seems to move on again. Alkalies taken before meals stimulate the flow of the gastric juices. Slight fatigue often spoils the appetite, and lowers the digestive power. Nothing so securely revives this as a glass of wine before meals. While small quantities of alcohol aid digestion, larger quantities retard it and encourage gastric catarrh. The quantity of wine or brandy must be small when taken for this purpose.

THE OLDEST AIR-BREATHERS.

WE alluded in the March number of the "Monthly," to the fossil scorpions recently discovered in the Upper Silurian formations of Sweden and Scotland, recognizing them as the most ancient specimens of land or air-breathing animals yet found. The subject has since gained a new interest through the discovery of a still older fossil of an insect, and by these our knowledge of the land of the earth and of some of its inhabitants is carried back by at least two immense geological periods. We therefore give place to a fuller account of the discoveries, with portraits of these newly found oldest inhabitants of the solid part of the globe, collating the facts and borrowing the illustrations from

the French and English scientific journals. Scorpions had already been found quite abundantly in the lowest carboniferous strata. The first palæozoic specimen that came to light (*Cyclophthalmus senior*) was found in the coal formation of Chombe, Bohemia, and was described by Count Sternberg in 1835. Three years later another scorpion (*Microlabis*) was described from the same locality. The next discoveries were American, and were made in the coal-measures of Illinois, of two genera which Meek and Worthen described as *Eoscorpius* (dawn-scorpion) and *Mazonia* (from Mazon Creek, where they were found). In 1873 Dr. Henry Woodward showed that *Eoscorpius* remains occurred in the coal-measures of England and in the carboniferous limestone of Scotland; and in 1881 Mr. Benjamin N. Peach described a considerable number of scorpions which had been obtained by the officers of the Geological Survey of Scotland from the lowest carboniferous rocks of the Scottish border. In his paper, which was published in the "Transactions" of the Royal Society of Edinburgh, he pointed out the general resemblance and almost equally high organization of these ancient scorpions and those of the present day, and expressed regret that Messrs. Meek and Worthen had given the name of *Eoscorpius* to their specimens, "for the dawn of the scorpion family must have been at a much earlier period, and we may hope that their remains will yet turn up in the Devonian and Silurian plant-beds when these come to be thoroughly searched."

This prediction has been verified in the discovery of the Scotch and the Swedish Silurian fossils. The Scotch scorpion was discovered first, by Dr. Hunter, of Carluke, who obtained his specimen from Lesmahagow, in Lanarkshire, in June, 1883; but the Swedish professor, Lindström, although a year later in discovery, anticipated him in announcing it and in publishing the description of his fossil.

In a letter of November 24, 1884, to M. Alphonse Milne-Edwards, Professor Lindström says of his scorpion (Fig. 1): "The specimen is in sufficiently good preservation, and shows the chitinous brown or yellowish-brown cuticle, very thin, compressed, and corrugated by the pressure of the superposed layers. We can distinguish the cephalothorax, the abdomen, with seven dorsal laminæ, and the tail, consisting of six segments or rings, the last narrowing and sharpening into the venomous dart. The sculpture of the surface, consisting of tubercles and longitudinal keels, entirely corresponds with that of living scorpions. One of the stigmata on the right is visible, and clearly demonstrates that it must have belonged to an air-breathing animal, and the whole organization indicates that it lived on dry land." Professor Lindström points out, as a feature of great importance in the conformation of the animal, the existence of four pairs of thoracic feet, large and pointed, resembling the feet of the embryos of several other tracheates and animals like the *Campodea*. This form of feet, he remarks, "no longer exists in the fossil scorpions of the carboniferous

formation, the appendices belonging to which resemble those found in the scorpions of our own day." This species has been named *Palæophoneus nuncius*.

The Scottish specimen (Fig. 2) is described by Mr. Peach in "Nature" as being about an inch and a half long, and lying on its back

FIG. 1.—FOSSIL SCORPION (*Palæophoneus nuncius*), found in the Silurian rocks of the Island of Gottland, Sweden. From the photograph sent by Professor Lindström to M. Alphonse Milne-Edwards. (From "La Nature.")

on the stone. "Its exposed ventral surface shows almost every external organ that can be seen in that position, and in this way serves to supplement the evidence supplied by the Swedish specimen. As in the northern individual, the first and second pair of appendages of the

cephalo-thorax in the Scottish example are chelate, but the palpi are not quite so robust. The walking-limbs, though not so dumpy as in *P. nuncius*, also terminate in a single claw-like spike. The arrangement of the sternum shows a large pentagonal plate (metasternite), against which the wedge-shaped coxæ of the fourth pair of walking-limbs abut. The coxæ of the third pair bound the pentagonal plate along its upper margins, and meet in the mid-line of the body, where they are firmly united. The coxæ of the first two pairs, as well as the bases of the palpi, are drawn aside from the center line of the body, showing that, as in recent scorpions, these alone were concerned in manducation, or rather the squeezing out of the juices of the prey; from the circumstance of these being drawn aside, the medial eyes are seen pressed up through the cuticle of the gullet, and a fleshy labrum (camerostome) appears between the bases of the chiliceræ.

"Behind the pentagonal plate and the coxæ of the hindmost limbs there succeeds a space shaped like an inverted V, where the test is thin and wrinkled in the line of the long axis of the body. It is just along this line that the trunk or abdomen most easily separates from the cephalo-thorax in recent scorpions, and it is at once apparent that the trunk in this case is as far separated from the cephalo-thorax as it can well be without being detached. Similar longitudinally wrinkled skin is seen to unite the dorsal and ventral scutes up the whole right side of the trunk. At the interior angle of the inverted V there hangs downward a narrow bifid operculum flanked on each side by the combs, which have each a broad triangular rachis set along its lower edge with the usual tooth-like filaments. The combs almost hide the first of the four ventral sclerites, which bear the breathing apparatus in recent scorpions, notwithstanding which all four of these exhibit on their right side undoubted slit-like stigmata at the usual places. The fifth ventral scute of the trunk suddenly contracts posteriorly, and to its narrow end is articulated a long tail of five joints and a poison-gland with a sting. These joints are all constructed on the same principle as those of recent scorpions, and, as the articular surfaces are more highly faceted on the dorsal than on the ventral aspect (a portion of the tail of the specimen lying sidewise allowing of these observations), there can be no doubt that the animal was in the habit of carrying the tail over the head (so to speak), and stinging in the same manner as its recent congeners." These characters are shown in the accompanying illustration (Fig. 2), which is on the same scale as that of the figure of the Swedish example (Fig. 1), viz., about twice the natural size.

The animal is supposed to have wandered to the sea-shore in search of food, and there been imbedded in marine strata. From the completeness of the remains, it is evident that it can not have been carried far out to sea; the rocks of the formation in which the fossil was

found abound in Eurypterids, or fossils of a crustacean allied to the king-crab.

Of the recent discovery of earlier Silurian insects, we have the following account given by M. Charles Brongniart to the French Academy of Sciences :

"Fossil insects have been found in the carboniferous strata. The coal-beds of Commentry have furnished some thirteen hundred specimens, and Mr. Scudder has described six specimens that were found in the Devonian beds of New Brunswick ; but, until very recently, no representative of that class had been detected in any of the more ancient formations. M. Douvillé, a professor in the School of Mines, has shown me a piece of Middle Silurian sandstone from Jurques, Calvados, bearing a distinct impression of an insect's wing (Fig. 3). The state of preservation is not perfect, but we can still distinguish most of the nervation. The wing, which is about thirty-five millimetres long, belonged to a *blattid*, an insect of the cockroach family. The humeral field is broad, and upon it may be seen the superior humeral vein ; the inferior humeral vein, bifurcated at its extremity ; the vitrean or median vein, likewise divided into two branches ; the upper and lower discoidal veins, with their very oblique divisions meeting again at the end, just as they may still be

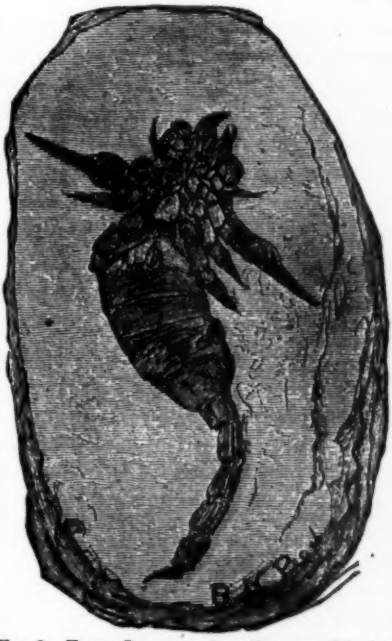


FIG. 2.—FOSSIL SCORPION, from the upper Silurian rocks of Lesmahagow, Lanarkshire, Scotland, found by Dr. Hunter, Carluke. (Magnified two diameters.)

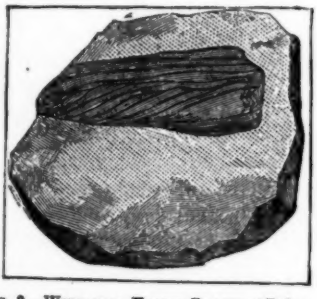


FIG. 3.—WING OF A FOSSIL BLATTA (*Palæoblattina Douvillei*), in a piece of Silurian sandstone (natural size).

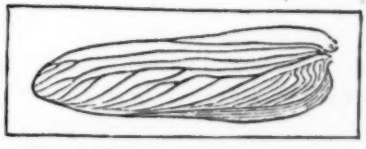


FIG. 4.—RESTORATION OF THE FOSSIL WING.

seen to do on some living *Blattæ;* and we can follow the anal vein, which is nearly straight and extends almost to the end of the wing, together with the axillary veins parallel to it. The remarkable feature which distinguishes this impression from the wings of all other blattids, living and fossil, is the length of the anal nervature and the scant width of the axillary field. Among the blattids of the coal period, the *Prognoblattina Fritschii* (Heer) and the *Gerablattina fascigera* (Scudder) have a nervation a little resembling that of our Silurian wing. We propose to name this ancestor of the *Blattæ, Palæoblattina Douvillei,* in honor of Professor Douvillé.

"Geologists regard as identical the sandstones of May and Jurques

FIG. 5.—LIVING BLATTÆ, male and female (*Blabera claraziana*), from Mexico.

in the Calvados, and place them in the Middle Silurian, while the schists of the Island of Gottland belong to the Upper Silurian. Our blatta-wing, then, must be regarded as older than the scorpion described by Professor Lindström and the other similar scorpion from the Upper Silurian of Lanarkshire."

Besides the engraving of the actual fossil wing in Fig. 3, we give in Fig. 4 an ideal restoration of the same; and in Fig. 5, for comparison, a representation of a living blatta from Mexico, the venation of whose wings nearly corresponds with that of the fossil.

SKETCH OF PROFESSOR S. P. LANGLEY.

By EDWARD S. HOLDEN.

I HAVE been asked to write a sketch of the life of Professor Langley, to accompany his portrait in this number of "The Popular Science Monthly."

Something of the life of every scholar and of every public man belongs to his audience; while most of that personality which endears him to his friends is their private possession, not to be set forth, except within narrow limits.

Professor Langley was born at Roxbury (now Boston), August 22, 1834. Like many another Boston boy, he was sent to the Boston Latin School, where Latin and Greek and little else was taught.

Latin and Greek was reputed to be the sum and end of learning, and Harvard College seemed to show dim perspectives of more Latin and Greek. It was no wonder that young Langley, whose genius lay in quite another direction, should look about him, after his graduation from the school, to see if there were not some practicable way in which he could pursue those mechanical and astronomical studies that already had fascinated him. He had little inclination to enter college, and the openings in astronomy proper were very rare in those years, even rarer than now. Since he was ten years old, he had been reading and studying astronomy, making small telescopes, using these and others, with various success, but always with ardor. The practical question of how to shape his life was one that had to be solved, and a variety of causes led to his determination not to go to college, but to become a civil engineer. Here at least was a profession whose basis was mathematical, and in which mechanical tastes and acquirements would have scope. So the practice of engineering was begun; special circumstances forced him into architecture, and for some years this was his pursuit. These were dull years, mostly spent in the West, where at that time there were few opportunities to display any real ability in this special calling.

There is little doubt but that the long and dreary hours spent over the drawing-table were an admirable though tedious preparation for the series of astronomical delineations which have been of so solid a use to science. But, finally, in the lack of real opportunities, architecture ceased to be a profession, and became a business, a means to live simply.

In 1864 Langley felt the need of some marked change in his life, and he spent the greater part of the years 1864 and 1865 in Europe.

In 1865 he returned to America, then thirty years old, and found himself entirely free, for the first time in his life, to follow his own inclinations. So, at thirty, instead of twenty, we find him as one of

the regular assistants at the Harvard College Observatory. From this time forward he belongs to astronomy, although many an obstacle was yet to be overcome before he could freely exercise his special and high talents.

After a few months at Harvard, Langley was offered the position of Professor of Mathematics at the United States Naval Academy at Annapolis. Before the war, a small observatory had been founded at Annapolis by Professor Chauvenet. It contained a six-inch equatorial, and an exquisite meridian circle, by Repsold, with which Chauvenet had already made some observations. The removal of the Academy to Newport and the resignation of Professor Chauvenet left these instruments unused, and it was Langley's first business to remount them and to place the small observatory on a working basis. The next year was an apprenticeship in the practice of astronomy. In 1867 Professor Langley was invited to become the Professor of Astronomy in the Western University of Pennsylvania (at Pittsburg), and to take charge of its observatory on one of the high hills across the river (Allegheny City). The previous history of the observatory had been a checkered one, and its equipment was in the last degree inadequate and incomplete.

It had been built in a good situation; there was a dilapidated dwelling-house on the grounds; the observatory building itself was there; an equatorial of thirteen inches aperture was mounted; but this was all. Everything was bare; the equatorial was not provided with the necessary apparatus; the observatory was entirely empty, except for a table and three chairs; and the professor was expected to be active there, while at the same time he was to attend to the full duties of a chair at the college; no assistants were provided, and the observatory had no income! It is hardly possible to conceive a situation more tantalizing and less hopeful.

A way out soon suggested itself. For the prosperity of the observatory some definite income was essential, and it was absolutely requisite to *earn* this. What has an observatory to sell, that the business men of Pittsburg—the railways, the iron-masters, the glass-founders—will buy? Clearly, the only thing they want is the correct time. But will they pay for it? This was what Professor Langley set himself to provide, and by 1869 the full system was in successful operation and yielding a fair income to the observatory. For some years before, certain other observatories had established more or less complete time-services (at Albany, Washington and elsewhere), but the system at Allegheny was the most complete and elaborate of any, and the first which was looked to for an adequate support of an observatory.

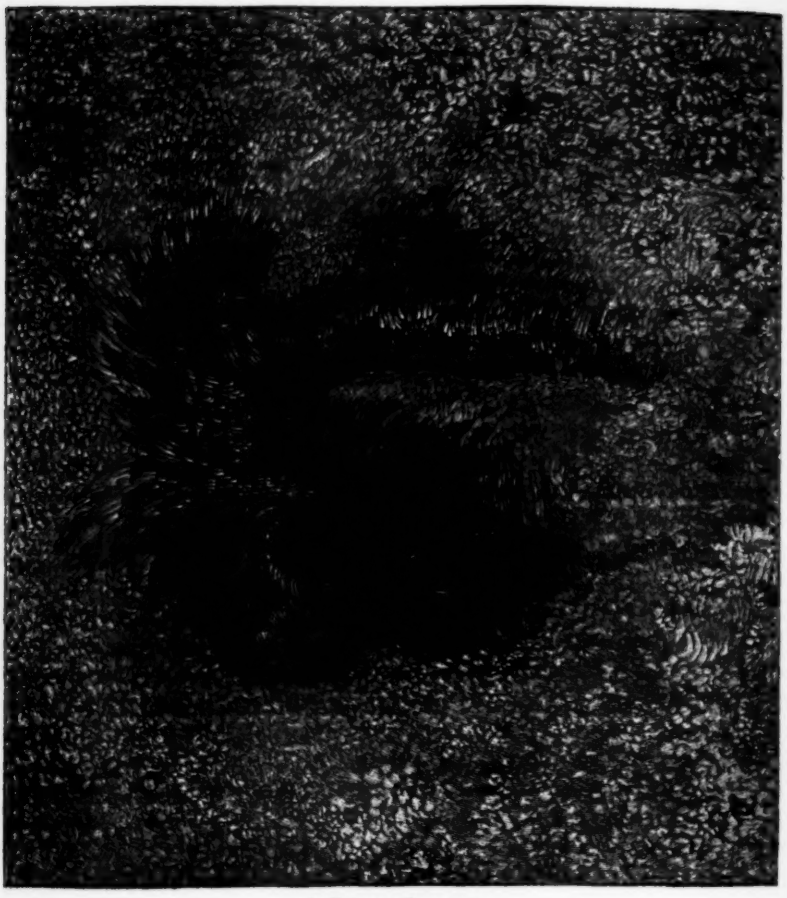
Besides regulating the public time of Pittsburg and of numerous private offices, the observatory provided the standard time for the whole system of railways centering in Pittsburg, and daily sent (auto-

matically by electricity) the beats of its standard clock over the telegraph lines from New York and Philadelphia west as far as Cincinnati and Chicago, north to Lake Erie, and south to Washington. This system is still in full operation, and has always maintained a high character for accuracy.

The United States Coast Survey organized several parties to observe the total eclipses of 1869 and 1870, and Professor Langley went to Oakland, Kentucky, in 1869, as a member of the party of his friend Professor Winlock, Director of Harvard College Observatory. In 1869 his station was upon the very edge of the shadow, and the object of his observation was to determine the limit of total eclipse. In 1870 the station assigned to Professor Langley was at Xeres, in Spain, where he determined the polarization of the solar corona to be radial.

During the year 1870 the affairs of the observatory began to assume such a shape that some time for original work in astronomy was available. The success of the time-service had created a small fund out of which the more pressing needs of instrumental equipment were provided; and Professor Langley now began a period of the most incessant work on the minute study of the features of the sun's disk. The situation of his observatory at Pittsburg, where dense clouds of smoke and dust and dirt obscure the heavens, and the meager state of his instrumental equipment, almost forced him to take up the study of the sun, which has light enough to penetrate even a Pittsburg fog. Fortunately, this study demanded very few auxiliary pieces of apparatus: the telescope has to be directed upon the sun, its motor-clock keeps it constantly pointed upon the same spot, and the observer has to follow, with infinite diligence and patience, the elusive details which the moments of best vision may allow him to glimpse. Two very important and rare qualifications are also necessary. The observer must be entirely unprejudiced and impartial; recording that which he sees, whether it is expected or not, and recording nothing which he does not see, no matter how firmly he may be convinced that it ought to be visible. This is the first qualification—one of unusual mental constitution; and the second is one of unusual manual skill. The observer must be able to delineate the most extraordinary and complex details justly and correctly. Both of these unusual qualifications Professor Langley possesses in a marked degree. His well-known and most beautiful drawing of a "Typical Sun-spot" illustrates this. This has since been copied in very many places, and it has received the very highest praises from all competent judges.

Professor Langley's earliest published paper on the sun (February, 1874) may be taken as a type of his best work. It possesses that hardly-definable quality by which we become aware that it was written from a full mind. It is only fifteen pages long, yet we are not conscious of undue brevity. One has a sense, in reading, that every state-



A Typical Sun-spot.

ment of fact, or every expression of opinion, is based upon a hundred single instances like the one which is chosen, or upon a hundred concurring judgments. It is not that you are overborne by weight but convinced by character. This most important paper came at exactly the right time. It first summarizes the works of other recent observers, which, though important, had left the subject in an entirely unsatisfying condition, and then proceeds straight to the subject in hand.

The minute details, both of the general solar surface and of the extraordinarily complex spots, are one by one satisfactorily and lucidly described, with indications of the physical conditions to which they are due; and, finally, the general bearings of all this on the received solar theories are briefly set forth. We may fairly say that this paper is fundamental. It treats of a subject of which little had been accurately known, and it leaves this subject in a satisfactory and settled

condition. Four years of labor on this subject had not failed to suggest many other researches.

A detailed study of the distribution of the heat of the solar surface was begun about this time, by means of the thermopile, and was quickly rewarded by the discovery of an unknown thermo-chroic action in the sun's atmosphere, such that it transmits the light less readily than the heat, owing to the difference in wave-length. An interesting consequence of this action is that, if, at any time, the sun's atmosphere should grow thicker, the color of the sun would tend toward red ; if thinner, then toward blue. These changes, which are quite possible, suggest interesting explanations of some of the phenomena of the variable stars. The glacial epochs on the earth may be connected with changes in the solar atmosphere.

In 1877 we find another outcome of the series of measures of the heat from various parts of the sun's disk, and especially from the umbræ, etc., of sun-spots. The periodic changes in the spotted area of the solar disk, which had long been known, induced the inquiry whether changes in the *amount* of spotted surface bore any relation to changes of temperature on the earth's surface.

The result of the extremely delicate measures of Professor Langley led plainly to the conclusion that the *direct effect* of sun-spots on terrestrial temperature is sensible ; that, when the spotted area is a maximum, the temperature is on that account lower, and the converse ; but that the total direct effects of the periodic changes in the spotted area on the earth's mean temperature are extremely small, not more than a change of three tenths of 1° C. in eleven years, and not less than one twentieth of 1° C. The *indirect* effects are not here considered.

A thermopile used in connection with the most sensitive galvanometers is an extremely delicate instrument ; and Allegheny Observatory now possessed a most complete outfit of this sort.

But the most important and pressing questions in solar physics demanded a means of measurement of heat still more delicate. When it was a question to measure the heat radiation from the different parts of the sun's disk, the thermopile was adequate. But if the heat from one of these parts is spread out into a heat-spectrum several feet or even yards long, it becomes necessary to devise new means of measuring the minute differences between the various parts. Such a device is the bolometer, which consists of two systems of extremely thin steel or platinum strips. Through these two systems an electric current passes. A sensitive galvanometer connected with both systems keeps its needle steady when the currents are equal.

If one system is now exposed to heat radiations while the other is protected from them, the temperature of the first is raised, its electric resistance is increased, and the battery-currents through the two systems and the galvanometer no longer balance. The galvanometer-

needle then moves, and the amount of this motion measures the amount of heat disturbance. The sensitiveness of the instrument is from ten to thirty times greater than that of the most delicate thermopiles possible, and its constancy specially fits it for its work. The years 1879 and 1880 were given to perfecting this new and powerful instrument. Some of its first results were to show, by direct experiment, that the maximum of heat in the normal spectrum was in *the orange*, not the *infra-red* (then an interesting fact); and that the solar-constant,* as determined by previous methods, was decidedly too small. The most suitable methods of determining this important *constant* were pointed out.

In 1881 Professor Langley organized an expedition to the top of Mount Whitney, in California, for the purpose of applying these new methods under the most favorable conditions. The expenses of the expedition were jointly borne by the United States Signal Service and by the private subscription of a wealthy gentleman in Pittsburg, who had now for some years taken the greatest interest in the researches of the observatory, and whose liberality had provided many of its instruments.

His name *ought* to be here mentioned. He has materially aided science in the most liberal and thoughtful way; but, against his expressed wish that he should be nameless in this connection (as he is in hundreds of other kind deeds), I have no right to contend.

The most important single result of the previous experiments with the bolometer had been the establishment of the fact of *selective absorption* of the solar rays by the earth's atmosphere. The results of this action are so important that I may be permitted to quote from Professor Langley an elementary exposition of them. He says: "Our observations at Allegheny had appeared to show that the atmosphere had acted with *selective* absorption to an unanticipated degree, keeping back an immense proportion of the blue and green, so that what was originally the strongest had, when it got down to us, become the weakest of all, and what was originally weak had become relatively strong, the action of the atmosphere having been just the converse of that of an ordinary sieve, or like that of a sieve which should keep back small particles analogous to the short wave-lengths (the blue and green), and allow freely to pass the large ones (the dark-heat rays). It seemed from these observations that the atmosphere had not merely kept back a part of the solar radiation, but had totally changed its composition in doing so—not by anything it had put in, but by the selective way in which it had taken out, as if by a capricious intelligence. The residue that had actually come down to us thus changed in proportion was what we know familiarly as 'white' light, so that white is *not* 'the sum of all the radiations,' as used to be taught, but

* The amount of heat received from the sun's rays, falling perpendicularly on a square metre of the upper surface of the earth's atmosphere, in a minute of time.

resembles the pure original sunlight less than the electric beam which has come to us through reddish-colored glasses resembles the original brightness. With this visible heat was included the large amount of invisible heat, and, if there was any law observable in this 'capricious' action of the atmosphere, it was found to be this, that, throughout the whole range of the known heat-spectrum the large wave-lengths passed with greater facility than the shorter ones."

The effect of this selective absorption on the *visible* rays is to cut out the shorter wave-lengths proportionally more; so that to an eye outside of the earth's atmosphere the sun would be far *bluer* than to us. On the heat-rays taken together, the total amount of the absorption is very great, far greater than had been previously supposed. Professor Langley's experiments give a very great increase in the amount of solar heat reaching the earth over previous determinations, so that for example, according to him, the solar radiation is sufficient to annually melt an ice-shell one hundred and seventy-nine feet thick all round the earth. According to previous determinations, one hundred and ten feet in thickness could be melted. But while Professor Langley finds a vastly greater *amount* of heat supplied by the sun, his law of the selective absorption comes in to profoundly modify its terrestrial manifestations. *Were there no such selective absorption, the temperature of the soil in the tropics, under a vertical sun, would probably not rise to that of the freezing-point of mercury.* "The temperature of this planet, and with it the existence, not only of the human race but of all organic life on the globe, appears, from the results of the Mount Whitney expedition, to depend far less on the direct solar heat" than on the hitherto neglected quality of selective absorption.

The bearing of the observations at Mount Whitney on a great number of important questions, the temperature of the sun, the radiation from the sky, etc., etc., can not be here considered for want of space. The solar spectrum previously known was but half of that mapped out by the expedition, and there is good reason to believe that Professor Langley's observations have now revealed the whole of it to us.

The partial results of these investigations, published from time to time in foreign periodicals, have done much to make Professor Langley honored in other countries than his own. In 1882 he was invited to address the British Association for the Advancement of Science at Southampton, and did so. His paper on that occasion reminds one of that of February, 1874, in the astonishing fullness of experiment, thought, and judgment which seems to lie just back of the sentences. It comes from a full mind. In the spring of 1885 Professor Langley goes to England at the invitation of the Royal Institution to lecture before it.

There are many other most interesting researches of Professor Lang-

ley's which should be referred to here, were it not for limited space. His observations on the moon's heat; on the solar eclipse of 1878 (at the summit of Pike's Peak); his direct comparison of the sun with the molten metal of a Bessemer converter; his investigations at Mount Etna, Pike's Peak, and Mount Whitney, on the conditions of vision at great altitudes, all deserve more than this brief notice.

His published scientific papers are very numerous. A list of the more important of these follows this article. There are forty-six separate papers in the years from 1869 to 1885. Besides these, the magazines have contained many more popular articles; and his courses of lectures at the Lowell Institute, the Peabody Institute, and elsewhere, have been most successful.

Professor Langley is a member of the National Academy of Sciences and of numerous American and foreign bodies, and has received the recognition of honorary degrees from various universities.

PROFESSIONAL AND OTHER PAPERS BY S. P. LANGLEY, IN CHRONOLOGICAL ORDER.

No.	Date.	Title or subject.	Where published.
1	August, 1869....	Eclipse of August, 1869	"United States Coast Survey Reports."
2	December, 1869..	Proposed Plan of Time-Service...	Pittsburg.
3	January, 1871...	Eclipse Expedition of 1870.....	"Nature," January, 1871.
4	February, 1871..	A New Form of Solar Eyepiece ...	"Franklin Institute Journal," February, 1871.
5	April, 1871	Observations on Eclipse of 1870...	"United States Census Reports."
6	September, 1872.	*American System of Electric Signals*	"American Journal of Science," November, 1872.
7	August, 1873....	The Solar Photosphere	"Proceedings of the American Association," 1873.
8	February, 1874..	*Minute Structure of Photosphere* ..	"American Journal of Science," February, 1874.
9*	Aug. & Sept., 1874	External Aspects of Sun, with *Typical Sun-Spot* Plate	"Franklin Institute Journal," August, 1874.
10*	September, 1874.	Photosphere and Sun-Spots	"Popular Science," September.
11*	December, 1874..	Transit of Venus.....	"Popular Science," December.
12*	March, 1875.....	Sources of Solar Heat (lecture)....	"New York Tribune," Mar. 10.
13	March, 1875.....	*Comparison of Theory and Observation* ..... See, also, Memorie degli Spettroscopisti, *Typical Sun-Spot Plate with each Memoir.*	"American Journal of Science," March.
14	March, 1875.....	Temperature Relative des, etc.....	"Comptes Rendus," Mar., 1875.
15	September, 1875.	Radiations Superficielles de Soleil..	"Comptes Rendus," Sept., 1875.
16	September, 1875.	The Solar Atmosphere	"American Journal of Science," 1875.
17	November, 1876..	*Effect of Sun-Spots on Terrestrial Climate*	"Royal Astronomical Society Notices," November.
18*	April, 1877.....	The first "Popular Scientific Treatise"	"Popular Science," April, 1877.
19	May, 1877.....	Nouvelle Methode, etc. ..... See, also, "American Journal of Science," August, 1877.	"Comptes Rendus," May, 1877.

No.	Date.	Title or subject.	Where published.
20	July, 1877.....	Possibility of Transit Observations without Personal Error	"American Journal of Science," July, 1877.
21*	April, 1878.....	Electric Time-Service	"Harper's Monthly," April.
22	April, 1878.....	Photographs and Optical Studies ..	"American Journal of Science," April.
23	June, 1878	Transit of Mercury of May 6th....	"American Journal of Science," June.
24*	1878–1879.....	Six Articles on the Sun	"Scientific American."
25	October, 1878...	*Pike's Peak Observations of Eclipse of 1878*.....	Washington Observatory publication.
26	October, 1878...	Remarkable Groups in Lower Spectrum (A and B lines).....	"Proceedings of the American Academy."
27	October, 1878...	Temperature of the Sun (Bessemer Converter, etc.).....	"Proceedings of the American Academy."
28	August, 1879....	Saratoga Address as Vice-President of the American Association....	"American Association."
29	July, 1880.....	Observations on Mount Etna	"American Journal of Science."
30*	July, 1880.....	Wintering on Etna.....	"Atlantic Monthly," July.
31	January, 1881...	*The Bolometer and Radiant Energy*	"Proceedings of the American Academy."
32	March, 1881.....	The Actinic Balance.....	"American Journal of Science."
33	March, 1881.....	Sur la Distribution de l'Énergie, etc.	"Comptes Rendus."
34	March, 1881.....	Distribution de l'Énergie.....	"Comptes Rendus."
35	March, 1881.....	Distribution de l'Énergie.....	"Annales de Chimie et de Philosophie."
36	September, 1882.	*Observations du Spectre Solaire*....	"Comptes Rendus."
37	October, 1882...	Sunlight and Skylight.....	"Nature." See, also, "American Journal of Science."
38	December, 1882..	Transit of Venus	"Monthly Notices of the Royal Astronomical Society." See, also, Ast. Nach.
39	March, 1883.....	*Selective Absorption of Solar Energy* See, also, Weidemann's "Annalen," "Annales de Chimie et de Philosophie," London edition; and Dublin "Philosophical Magazine," for republication in full.	"American Journal of Science."
40	June, 1883.....	The Spectrum of an Argand-Burner.	"Science," June, 1883.
41	March, 1884.....	On the Measurement of Wave-Lengths, etc..... See, also, above-cited journals for republication in full.	"American Journal of Science."
42	September, 1884.	Amount of the Atmospheric Absorption	"American Journal of Science." See, also, London edition, and "Dublin Philosophical Magazine."
43*	September, 1884.	The New Astronomy	"Century Mag.," September.
44*	October, 1884...	The New Astronomy	"Century Mag.," October.
45*	December, 1884..	The New Astronomy	"Century Mag," December.
46	1885.....	*Researches on Solar Heat*.....	"Signal-Service Professional Papers, No. 13."

NOTE.—The above list omits numerous minor publications. It includes original contributions to science (the more important in italics), and articles of a popular character (marked with *).

EDITOR'S TABLE.

A PERNICIOUS POLITICAL TENDENCY.

THERE is no more important subject for consideration in the present day than that which is involved in the question whether the powers of government ought to be extended or restricted. The tendency, as every one must be aware, is toward extension, not restriction, and one of our contemporaries, the "Christian Union," snubs a correspondent who suggests restriction by telling him that he is "about half a century behind the times." The earliest form of government, it proceeds to say, is military despotism, the next is one of police regulation; while the happy dispensation under which we now live is one of industrial co-operation. Government is "organized to do for the community, by community action, whatever it can do better in that way than in any other." This is a little enigmatical, suggesting as it does that "government" might proceed in a great many other ways than by community action; but we may perhaps assume the meaning to be that government is organized to do for the community whatever can be better done through its agency than by any form of private effort or enterprise.

The first objection we make to this position is, that a great deal of ambiguity attaches to the word "better" as here employed. The resources of the Government are practically boundless; and that the Government, with boundless means, should do a particular work "better" than it would be done by private individuals with limited means, is not quite decisive of the question whether the Government should undertake the work or not. Anything can be done well if money without stint is applied to it; but the question remains, Are government methods of doing work really beneficial to the people? If the Government undertook to manage all the private gardens in the country, on the understanding that it might levy whatever taxes were necessary for the purpose, no doubt there might be a considerable improvement, on the average, in the way in which lawns and flower-beds and vegetable patches would be kept. It would take time to organize the necessary army of gardeners and laborers; but the thing could probably be accomplished in the end. There would be fat places for the politicians and clerkships without number, in addition to the actual outside workers; but the vast machine would sooner or later be brought into motion; and then no doubt some people, carried away by their admiration for the greater uniformity of government work, would proclaim that the principle of state management had scored another triumph. But meanwhile where would the money come from? Would the whole question of expediency be decided by pointing to the fact, if it were a fact, that, on the average, gardens were kept in better shape by the Government gardeners than they had been by the private owners? Would not the question of economy call loudly for consideration? And would it not be a further question whether Government was not doing more harm by diminishing the power of individual initiative than it was doing good by keeping hedges, and borders, and walks in superior trim?

When, therefore, we hear of Government doing this or that thing "better" than private enterprise would do it, we should like to go below the surface of things and examine a little into underlying questions, economical and moral. Every one seems to admit that a be-

nevolent despotism would do certain things "better" than they are done by our republican Government. Why is it, then, that we will not hear of any kind of despotism—that our repugnance to a benevolent despotism is scarcely less than our repugnance to a purely selfish one? Because we hold that the word "better," as applied to the work of a despotism of any kind, is a very shallow "better"; and that, while certain superficial aspects of the national life might be improved under such a *régime*, the deep and abiding interests of the country would suffer. Well, what people have to learn is that something despotic attaches to all government action outside of the sphere which peculiarly belongs to government, the protection of the community from foreign, and of individuals from private, aggression. All government action is of a compulsory character; all takes away something from the liberty of the individual; all stands in the way of the spontaneous development of the agencies for doing what the Government unnecessarily undertakes. Social bonds are not knit by what the Government does, but social bonds are knit by every development of private enterprise, by every spontaneous development of means to ends for social purposes. If government managed everything for us, society in the true organic sense would cease to exist. The individual would find himself at every turn face to face with a great mechanism, and would no longer have the sense of belonging to a living and growing system. It is easy to sneer at these ideas as being "half a century behind the times"; but whoever does so should remember that at least one illustrious name stands associated with them, and that it is not usual to cite the author of the "Synthetic Philosophy" as a man left in the rear of the world's intellectual march. "Democracy," we are told, has left these notions behind, and will never take them up again. What democracy will or will not do in the future it is rash to assert; for our own part we venture on no predictions. We should just wish, however, to remark that it settles no question of right or wrong, truth or error, to say that "democracy" has done so and so. Democracy, we presume, is not infallible. These abstractions, however, are most misleading. Tell us the exact truth: that a certain community living under certain institutions, and at a certain stage in its intellectual and moral development has turned its back on a particular set of ideas; and we shall not only know precisely what you mean, but shall also be able to estimate the importance and value of your statement. But tell us that the abstraction "democracy" has done the same thing, and we are entitled to reply that no abstraction is capable of any such action.

On the principle our contemporary has laid down, it is impossible to say at what point state action should cease; for the more the state undertakes the more it is impelled to undertake. To add one new function to-day is to prepare for the addition of a dozen within a few years. Take the case of the English Government. Having the post-office under its control, it was led to make use of the post-office organization for the issue and payment of money-orders. Then followed the establishment of post-office savings-banks; then the absorption of the telegraph system; then the establishment of a parcel-delivery and general express business. On the Continent the post-office collects debts, pays newspaper subscriptions, and carries money in very much the same way as the express companies do here. Where is this kind of thing to stop? The larger the organization, the greater the temptation to apply it in some new way, or to accomplish by means of it some new object. There are those, no doubt, who think this increasing influence and interference of government a

hopeful sign, and who look forward to the day when government will seize upon all the great lines of industry and forever break the power of private enterprise; but few intelligent persons in this country are of this turn of mind. We would therefore say to those who wish to preserve upon this continent a society alive in all its parts and full of individual initiative and resource, to beware how they give heed to the seductive doctrine that government should undertake whatever it can do "better" than private individuals. We might pay too dear for having our garden-walks rolled by government rollers, and too dear in many other ways for the alleged benefits of official rule.

BEECHER ON EVOLUTION.

THE Rev. Henry Ward Beecher has worthily crowned his splendid career as a liberal religious reformer by announcing and entering upon a series of discourses to his congregation in exposition and defense of the doctrine of evolution in its religious aspects and bearings. The taking of this noble stand in a formal way at the present time is undoubtedly the most momentous act of his intellectual and professional life. At a time when most men are worn out and ready to retire, when enthusiasm is usually chilled and opinions become hardened and unadaptive, Mr. Beecher strikes into a new field with the fire of youth, and takes the leadership in a movement of religious reform of quite incalculable moment. He commits himself boldly and broadly to the most comprehensive, far-reaching, and revolutionary truth yet established by science, and which carries with it a total reconstruction of the relations of science and religion; and this he does in opposition to the narrow-mindedness and dull indifference of the community, and more especially to the organized ignorance, the sacred traditions, the inveterate prejudices, the bigotry and the intolerance of the theological world. We confess to unaffected admiration for the sagacity, the independence, the courage, the loyalty to conscience and to truth, that have prompted Mr. Beecher to take this brave and significant step.

Undoubtedly he has undertaken a very difficult task, and he is aware that he has not much child's play before him. But there are important advantages in his position; and the first of these is, his independence of religious organizations: he has to reckon only with his congregation. In various respects, no doubt, his audience is but poorly equipped to appreciate the value of facts and the force of reasoning on the subject of evolution. For it must be remembered that the proof of that great principle is not of a kind to be given to an uninstructed person at a sitting. It is the diversity, and wide concurrence, and cumulative confirmation of the evidences that give the overwhelming force of demonstration to the theory. It must be assumed that Mr. Beecher's congregation has not been very well prepared in the philosophy of evidence, any more than they are familiar with the sciences from which the proofs are derived. It consists of bright, intelligent people, whose mental cultivation has been chiefly in literature, politics, and theology; while in proportion to their proficiency in these will they rank low in science, knowing little of its facts and less of its spirit and method.

Nevertheless, Mr. Beecher's congregation has had a very valuable and important preparation, which will be pretty sure to carry them with him in the present movement. Evolution is by no means a thing of yesterday with Mr. Beecher; he has long been on the road to it. The doctrine of progress has been one of the favorite and most powerful elements of his preaching for a quarter of a century. It has been the key to his theological philosophy,

and his people have been trained into thorough familiarity with the conception as an all-interpreting principle in both theology and politics. Yet evolution is only the expansion and full scientific elucidation and wider sweep of application of the idea of progress. Nor is there anything now in evolution more fatal to orthodoxy than there was a generation ago in the first vague divergence from the old rigid dogmatic systems in recognizing a progressive element in religion. Mr. Beecher and his people have been themselves evolved into their present position, and might furnish an object-lesson in the law of development. There will probably be more trouble in accepting the newer *name* appropriate to the later stage of growth than there has been in assimilating the underlying truth.

We congratulate Mr. Beecher on his intrepid course, and his determination to bring his pulpit into harmony with those revelations of science that a rereshaping the thought of the age; and we commend his example to the numerous clergymen who give their private assent to evolution doctrine, and then go on promulgating the old beliefs from desks sacred to antiquated error.

SPREADING IT TOO THIN.

At a meeting of the Massachusetts Teachers' Association, held a short time ago, President Eliot, of Harvard, spoke in strong terms of the unsatisfactory character of the great majority of the so-called high-schools of the Commonwealth. Out of a total of two hundred and twenty-eight such schools, seventy-two only had as many as three teachers, and the whole together sent only one hundred and ninety-nine students to the colleges of the State during the year 1884. The simple fact, President Eliot states, is that the majority of the schools are not fit to prepare youths for matriculation at college, though in the general system of public-school education that is a recognized part of their function. "It has been the policy of the Board of Education," we are told, "to encourage small towns to establish high-schools in order that as large a percentage as possible of the population may have a school higher than the grammar-school within easy reach." That policy has been so far successful that over ninety per cent of the population nominally enjoy the privilege in question. The result, however, is a thinning and impoverishing of the education just in proportion to its extension. Seventy-five of the high-schools are maintained in towns of less than five hundred families. Nearly half of the whole number existing have less than sixty pupils each. President Eliot naturally calls for such a change in the law as may enable two or three or four smaller towns to establish a joint school, and employ in rendering it really efficient the funds which now are more or less frittered away upon the maintenance of two or more weak and inefficient schools. He also suggests that the colleges should meet the schools half-way by establishing liberal systems of options, so that no student need be debarred from the higher advantages that the colleges afford by his inability to pass an entrance-examination in one or two subjects in which he feels no interest, and which he has no ulterior intention of pursuing.

We call attention to this matter because we have reason to believe that the practical evil which the President of Harvard describes is not confined to the State of Massachusetts, but is widely prevalent throughout the country at large. It is a result, no doubt, of our democratic ideas, and of the local jealousies which, it will hardly be questioned, democratic institutions bring in their train, that we try to bring to every man's door what we bring to one man's door. The thing can only be accomplished, however, at the expense of a marked deterioration in the article sup-

plied. A good and well-equipped high-school can not, as things now are, be maintained in every village and township. We may have the name of the thing, but the reality we can not have. If the system could be worked at all it could probably be worked as successfully in Massachusetts as in any State of the Union; but President Eliot tells us that it does not work well there at all, and that, owing to the poverty of the great majority of the schools, a gap which ought not to exist, and which is inconsistent with the theory of the public-school system, has established itself between the so-called high-schools and the colleges. The schools ought to prepare their students for matriculation at the colleges; but the most of them neither do nor can do anything of the kind.

What applies to the high-schools applies also, generally speaking, to the colleges themselves. They are not what they ought to be, simply because there are too many of them. The consequence is, that there is a great deal of false and shallow culture abroad in the land. A college ought to be a place where a youth would be certain to come into contact with men of an altogether superior order of thought and attainment. It ought to be the center of a true intellectual life. Of all our colleges, how many answer this description? It is needless to say that the country does not possess a sufficient number of men of real intellectual mark to fill all the chairs in our innumerable "colleges." If it did, we should indeed be exceptionally favored. Now, the effect of shallow learning tricking itself out in the garb of real erudition is to confuse all intellectual perceptions and standards. We do not say that a little learning is a dangerous thing, but we say that a little learning that mistakes itself for great learning is apt to make more or less of a fool or a charlatan of its possessor. We do not know whether there is much to be gained by struggling against what seems to be one of the main currents of the time; but we are profoundly convinced that the cause of American culture calls for concentration not dispersion of effort, for centralization as opposed to localization, for the sinking of petty rivalries in the endeavor to found strong, permanent, and widely beneficial institutions. Let our common schools which penetrate everywhere be placed on as sound a basis as possible; let high-schools be established in centers where they can be vigorously and generously sustained; let our colleges and universities be proportioned in number to the need actually existing for the highest culture, and let them have such support as national and individual interest in such culture prompts—and we shall then have all the necessary means for making the American people the equals in education of any other nation in the world. At present we have a vast but somewhat disjointed apparatus, and the results, however soothing they may be in some respects to democratic pride, are, from the point of view of national culture, far from satisfactory.

We call particular attention to the weighty testimony of Dr. Edward Frankland, the eminent English chemist and sanitarian, to the claims of the Yellowstone National Park as a great American health resort in winter for invalids with chest and pulmonary difficulties. Dr. Frankland has investigated this subject long and carefully, and is especially familiar with the conditions and effects of the celebrated Engadine Swiss sanitarium in the valley of Davos. Dr. Frankland came to this country last summer, attended the British Association at Montreal, and, having heard much of the Yellowstone Park, he went there and spent considerable time in examining its claims as a great winter sanitarium for the American people. He contributes to the "Monthly" a valuable

paper, giving the results of his observations, and the more valuable, as it is a comparative study of the health-merits of the two localities; the marked advantages being in favor of the Yellowstone Park over the celebrated Swiss valley. The article is most instructive, and the subject one of interest and moment to our people.

LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES, VOLUME L.

THE COMMON SENSE OF THE EXACT SCIENCES. By WILLIAM KINGDON CLIFFORD. With One Hundred Illustrations. New York: D. Appleton & Co. Pp. 271. Price, $1.50.

PROFESSOR CLIFFORD was applied to in 1871 to prepare a volume for the "International Scientific Series." He was asked if he would undertake a book to be entitled "Mathematics for the Non-Mathematical," the object of which should be to find out how far it is possible to go in explaining mathematical ideas to persons of intelligence who have had none of the higher mathematical training. This idea had been before proposed to several mathematicians, who agreed that nothing could be made of it; but it was suggested that if anything could be done with it Clifford's was the genius to do it. Professor Clifford was struck with the idea as novel and interesting, and said he would make a study of it and see what it promised. The result was so favorable that he decided to undertake the book and give such attention to it as his slender health and various pre-engagements would allow. There was but little doubt that the project was eminently suited to the peculiar characteristics of Clifford's mind; and that the subject was certain to be handled by him with originality and result in a valuable contribution to mathematical literature. But it soon became apparent that there was a serious question about the possibility of his accomplishing the task at all, on account of his declining health. He, however, did considerable work on it, but left it in an unfinished and fragmentary condition at his death in 1879.

In arranging the plan of the work it was Professor Clifford's intention to treat the fundamental conceptions of mathematics in six parts or chapters under the heads of Number, Space, Quantity, Position, Motion, and Mass. Of these six subjects he dealt with but four, dictating the chapters on Number and Space completely, the first portion of the chapter on Quantity, and nearly the entire chapter on Motion. Shortly before his death he expressed a wish that the book should only be published after very careful revision; that the title, *The First Principles of the Mathematical Sciences explained to the Non-Mathematical*, should be abandoned, and that the volume should be entitled *The Common Sense of the Exact Sciences*.

It was not easy to find a mathematician who would undertake to finish Professor Clifford's work. Upon his death, Professor Rowe, of University College, engaged to do it; but he also died before accomplishing the task, so that the final revision had to be made by still another hand. There are parts of this work contributed by Professor Clifford which answer finely to the original idea of it, and show what might have been done if he had lived and adhered to the first conception. A mistake was made by the subsequent editors in seeking to finish the work as they thought Clifford would have done it, rather than as in their judgment it might seem best. As it is, the work will probably be found more attractive to mathematicians than to non-mathematicians.

ANNALS OF THE ASTRONOMICAL OBSERVATORY OF HARVARD COLLEGE. Vol. XIV. Parts I and II. Observations with the Meridian Photometer during the Years 1879–'82. By EDWARD C. PICKERING, Director, aided by ARTHUR SEARLE and OLIVER C. WENDELL. Cambridge: John Wilson & Son, University Press. 1885.

ALMOST the earliest record we have of astronomical observation is the catalogue of 1,028 fixed stars in the "Almagest" of Ptolemy, the epoch of which is A. D. 138. The chief value of this catalogue consists in its classification of the stars into six magnitudes, which classification, so far as those stars which are visible to the naked eye are concerned, has been continued to the present day. Since that time many other astronomers have made systematic observations on the relative brightness of the stars, the

comparisons up to the present century having been made either by the naked eye, or with the assistance of an opera-glass only. About the middle of this century photometers specially adapted for comparing the light of the stars were first used by German astronomers. Zollner invented a photometer, consisting of a telescope in which the light from a kerosene-lamp, admitted through a very small hole and presenting the appearance of a star, is compared with the real star under observation. C. S. Pierce, of the United States Coast Survey, used such a one in the construction of a photometric catalogue of 494 stars, published in Vol. IX of the "Annals of Harvard College Observatory." His description of his difficulties with this very imperfectly contrived and still more imperfectly constructed instrument would be amusing, if it did not excite regret that so accurate an observer and excellent a mathematician should have been weighted with an instrument so poorly adapted to the work.

Up to within a few years, only about 500 stars had been the subject of photometric observation, and for some time it has been regarded as highly desirable that systematic comparisons should be made of the light of all stars visible to the naked eye.

In Vol. XIV of the "Annals of the Observatory of Harvard College" we have the records of the most extensive and complete photometric observations ever undertaken. The great attention which Professor Pickering, the director of the observatory, has given to astro-photometry, and the large experience he has had with photometers, both of his own and others' construction, peculiarly fitted him for such a task.

Part I of the "Annals" opens with a description of the meridian photometer devised by Professor Pickering. Having ascertained by experiment that any change of position on the part of the observer had an injurious effect upon the observations, he constructed his instrument in the form of a broken transit, in which, the line of sight being always horizontal, stars at all altitudes could be observed without moving the head. Experience with other photometers had also satisfied him that no artificial light could be a proper standard of comparison for the light of a star. A real star was therefore chosen, and the fact that the pole-star is always visible, and its light, on account of its very slight changes of altitude, a constant quantity, directed him in his choice of it as the standard of comparison for all stars. To make sure that it was otherwise suitable, a large number of observations were made of the pole-star, to ascertain if its light was subject to any periodical variation.

A reliable instrument and perfect standard having been thus obtained, and many preliminaries settled which it is impossible to touch upon here, observations were begun in October, 1879, and continued till September, 1882. During this period seven hundred series of observations were made, including 94,476 separate comparisons, the result being that every star not fainter than the sixth magnitude, between the north pole and thirty degrees of south declination, was compared from three to fourteen times with the pole-star. The whole number of stars thus compared is 4,260.

The space to which this review is necessarily restricted renders it impossible to give even a passing notice to the immense amount of work expended upon the subject of astro-photometry as recorded in these "Annals." An idea can be formed from the statement that there are in all ninety-one tables, some of which occupy several pages. The "General Catalogue," constituting Table XXVII, alone occupies 211 pages, each line having twenty-six columns, one of which has fourteen sub-headings.

Part II of the "Annals," the publication of which has been delayed till the present year, is largely devoted to a discussion of the work of those astronomers, from Ptolemy to the present day, whose estimates of the relative magnitudes of the stars Professor Pickering has chosen for comparison with his own. A very complete list of all known or suspected variable stars is also given, with copious notes as to dates and observers. There is also a chapter on the distribution of the stars.

Professor Pickering does not close his work with the advancement of any theories of his own. But, for whatever purpose an exact determination of the relative magnitudes of the stars may be desired, either for the discovery of variable stars, or to as-

certain the position of the sun in the Galactic Cluster, this volume of the "Annals" fills a place which no other work yet published can make any pretense to. Whether we consider the perfection of the instrument employed, the plan of observation pursued, the accuracy and care with which the observations were made, the large number of stars observed, the completeness of the records, or the exhaustive comparisons that have been made of the observations with those of other astronomers, we are equally satisfied that, so far as the photometric observation of all stars visible to the naked eye in northern latitudes is concerned, the work of Professor Pickering and his able assistants leaves nothing to be desired.

THE CHEMISTRY OF COOKERY. By W. MATTIEU WILLIAMS. New York: D. Appleton & Co. Pp. 328. Price, $1.50.

SINCE the publication of Johnston's "Chemistry of Common Life," thirty years ago, no book so important has appeared in this line of inquiry as the volume before us. Johnston's work was of broader scope, and, in fact, contributed little to the science of the culinary preparation of foods, to which Williams's work is devoted. Much has been done in this direction in the last generation, and a work was needed embodying the most important practical results. This Professor Williams has now given us in a very satisfactory form. Of the extent and importance of the information conveyed in his pages nothing need be said to the readers of "The Popular Science Monthly," in which the successive articles have appeared; but, now that they are collected together and offered as a treatise on the science of cookery, it is proper to state that the work has been ably done, and is entitled to rank as a standard upon its subject. Mr. Williams has given us "the present state of knowledge" on the chemical changes to which alimentary substances are subjected by customary kitchen operations. His facts and his chemistry are to be relied upon, and his conclusions are generally made with judgment, but some of his speculations may be extreme, and will be received with caution. His work has been criticised as if he had made too much of the test-tube and analytical operations, and built unwarrantably upon their results. There are, of course, many things about organic substances and their subtile changes which chemistry can not explain, and it certainly can not give us a complete science of foods. But the author of the present work is quite aware of this, and we do not think he has unduly strained the resources of his science in his efforts to elucidate the subject. His book will prove invaluable to read, for practical instruction, for reference in using common cook-books, and as a text-book for classes wishing to study the science of cooking in a careful and thorough manner.

A TEXT-BOOK OF HYGIENE. By GEORGE H. ROHÉ, M. D., Professor of Hygiene, College of Physicians and Surgeons, Baltimore. Baltimore: Thomas & Evans. Pp. 324.

EVERY important division of the subject receives some attention in this treatise. It is intended to present the essential facts upon which the art of preventive medicine is based, in such manner as to form a guide for the American student, practitioner, and sanitary officer. Beginning with general considerations in regard to air, water, food, and soil, the author goes on to the special hygiene of dwellings, hospitals, and schools, and takes up also industrial, military, marine, and prison hygiene. Several chapters are devoted to personal hygiene. Histories of the epidemic diseases are given, and the subjects of disinfectants, quarantine, and vital statistics are also included. A list of special works is given with each chapter. The author makes little claim to originality; the qualities which he has especially sought are comprehensiveness and reliability.

THE MICROTOMIST'S VADE-MECUM. By ARTHUR BOLLES LEE. Philadelphia: P. Blakiston, Son & Co. Pp. 424. Price, $3.

THIS work—"a hand-book of the methods of microscopic anatomy"—has been prepared chiefly with the design of furnishing a complete but concise account of all the methods of preparation that have been recommended as useful for the purposes of microscopic anatomy. In order to make it also a suitable guide for beginners, a general introduction has been added, and introductory paragraphs have been prefixed, when needful, to the different chapters,

which, taken all together, go far to make up a formal treatise on the art. To furnish to instructed anatomists, for whom the book is primarily designed, information on points of detail as to which their knowledge or memory may be at fault, a collection of formulæ is given and a number of special methods are described. For beginners, again, a collection is furnished of examples, which are not intended for imitation, but as hints suggestive of the most fitting processes.

THE DIAMOND LENS, WITH OTHER STORIES. By FITZ-JAMES O'BRIEN. New York: Charles Scribner's Sons. Pp. 337. Price, paper, 50 cents.

MR. O'BRIEN was of Irish birth, a poet and story-writer of bright genius, whose contributions to the newspapers and magazines attracted much attention when they were published, and were generally popular and widely read, showing distinct originality and strong powers of penetration and description; they deserve to be remembered. The present series, including a baker's dozen of the stories, was published in 1881, with a biography of the author, by Mr. William Winter, and now appears again in a second edition.

THE LIFE OF SOCIETY. By EDMUND WOODWARD BROWN. New York: G. P. Putnam's Sons. Pp. 270. Price, $2.

THIS work is intended to present a general view of the various factors, in nature and man, that work upon the structure and methods of society, and of the influence, in turn, of society upon man. The author's object has been, in a systematic study, to obtain as deep and adequate a general conception of society as possible, "the society of any township or any country of the world to-day, or the whole world of society in the past. . . . I wish," he says, "to find an explanation of society that will suit wherever society is in any country, or has been in any country or age. I want to get a general view of the constant part of every society. I want to evidence and illustrate this by social and historic facts, drawn from the wide range of society in the past or the present." In general, he adds, "I hope, then, I have shown the real foundation of social science, though, doubtless, there are deficiencies." The subject is considered under the head of the effective causes acting upon society, among which are the influences of the body, man's intellect, man's will, habit and usage, disposition and feeling, etc.; then are considered various features of society, the influence of the parts of society upon one another, and of the whole upon the parts; the growth and progress of society; its incompleteness, imperfection, and deterioration; rhythm and epochs in the life of society; its laws, restraints, liberties, forms, and institutions; and, finally, a general view of the spheres of society. The work bears the marks of laborious thought.

THE LIMITS OF STABILITY OF NEBULOUS PLANETS, AND THE CONSEQUENCES RESULTING FROM THEIR MUTUAL RELATIONS. By Professor DANIEL KIRKWOOD. Pp. 110.

THIS monograph is an inquiry respecting the extreme limits within which a planet's atmosphere may exist, as measured by the distance from the planet's center, at which gravity and the centrifugal force will be in equilibrium; and further into the original or maximum values of the corresponding distances, which were much greater before the members of the system had contracted to their present dimensions. These found, the author applies the bearing of the answers to the discussion of the question, "Were the planets formed from nebulous rings?"

THIRD ANNUAL REPORT OF THE OHIO AGRICULTURAL EXPERIMENT STATION, for 1884. By WILLIAM R. LAZENBY, Director. Columbus, O.: Myers Brothers, State Printers. Pp. 240.

THE theory of the station, it is stated in the introductory part of the report, "is to tell the farmers of Ohio what they most need to know"; and much of the matter in the volume appears to answer to that description. Field experiments were conducted during the year with grasses, fruit, and garden vegetables. The primary object of the tests is to improve upon the best-known methods of cultivation and management. Among practical questions, earnest attention was given to ascertaining the comparative value of the best varieties; the effects of thick and of thin seeding; the effects of sowing or planting at different dates, different distances, and

different depths; the value of different methods of manuring and applying fertilizers; and the comparative merits of different systems of culture. In connection with this work chemical analyses were made; experiments were carried on in self- and cross-fertiiization; investigations were made in regard to the best treatment of certain insect enemies and plant-diseases; the climatic conditions were carefully noted; and the work begun in practical forest-tree culture was extended. The results of the investigations are intelligently and intelligibly described. We regard the document as a good specimen of what such a report should be.

AN INTRODUCTION TO THE STUDY OF THE COMPOUNDS OF CARBON; OR, ORGANIC CHEMISTRY. By IRA REMSEN, Professor of Chemistry in the Johns Hopkins University. Boston: Ginn, Heath & Co. Pp. 364. Price, $1.30.

THE arrangement of this book is somewhat different from that commonly adopted by teachers of organic chemistry. The lowest two members of the paraffin series are first considered, then, in order, their halogen, oxygen, sulphur, and nitrogen derivatives, and after these any peculiarities of higher paraffins and of their derivatives. Fifty pages are devoted to compounds which are at the same time alcohols and acids or aldehydes, etc. Next some account is given of the series of hydrocarbons homologous with the paraffins, and of their derivatives. The benzene series follows, and the various modifications and combinations of the ring molecule are described. Only the more important compounds in each group, and the more important reactions, receive attention. General directions are given for eighty-two experiments, a fair proportion of which the author advises each student to perform; for details in regard to analysis, etc., larger works are to be consulted. The author has taken pains to make the student see for himself the reasons for adopting the prevalent views in regard to the structure of the compounds of carbon, and has aimed to give a general view of the whole field, leaving minute descriptions to the chemical dictionaries. The book is a welcome addition to the unsatisfactory list of text-books in organic chemistry.

A REPRINT OF ANNUAL REPORTS AND OTHER PAPERS, ON THE GEOLOGY OF THE VIRGINIAS. By the late WILLIAM BARTON ROGERS. New York: D. Appleton & Co. Pp. 832. With Maps.

THIS republication is made in answer to requests by geologists and others for the reports, which have been several years out of print, or very rare. "Of the value of the scientific discoveries, the generalizations, and the descriptions of the geological formations contained in these reports," says the editor, "there can be no better evidence than the frequency with which they are referred to and quoted by all who are engaged in exploring the geology of the Virginias, and the aid they have given to the development of the industrial resources of these States, which they foreshadowed, and in fact often clearly pointed out, at a time when the geology of the State was unexplored." The reports are arranged substantially in the order in which they were made, with the preliminary correspondence and the arguments addressed to the Legislature for the continuance of the appropriations, so that they have an historical as well as scientific value. The author himself desired to condense and codify the reports, and present them with his special map and sections, as a single whole, but time and opportunity never came for doing so. Thus, the editor's work has been simply to revise the reproduction of the original reports and maps. But a number of papers additional to the reports, relating to the geology of the Virginias, have been embodied in the volume.

AN INTRODUCTION TO PRACTICAL CHEMISTRY, INCLUDING ANALYSIS. By JOHN E. BOWMAN, F. C. S. Edited by CHARLES L. BLOXAM, F. C. S. Eighth edition. Philadelphia: P. Blakiston, Son & Co. Pp. 248. Price, $2.

IN this manual is laid out a short course of laboratory work, beginning with general chemistry, and including something of both qualitative and quantitative analysis. The book has been made especially for college students who have not studied chemistry, and have time only to gain some familiarity with chemical operations, without devoting much attention to chemical philosophy. The author has avoided the use of complicated or expensive apparatus, and has aimed to give clear and full explanatory details of

the several processes. Quantities are given in English measures, followed by metric equivalents. In the part devoted to analysis are included blow-pipe tests and determinations of specific gravity. Several new examples of quantitative separation have been added in this edition, and volumetric analysis has been given a separate chapter. Ninety cuts illustrate the operations described. A dozen pages of technical information in regard to reagents are given, also tables of weights and measures, reactions, and solubilities, lists of salts for blow-pipe examination, etc. The uncut edges of the volume are rather inconsistent with the title, "Practical Chemistry."

THE FALLACY OF THE PRESENT THEORY OF SOUND. By HENRY A. MOTT, Ph. D. New York (printed for the author): John Wiley & Sons. Pp. 103. Price, 50 cents.

WE are informed on page 7 of this book that "in 1877 Dr. H. Wilford Hall published a work on the 'Evolution of Sound,' in which he carefully considered, step by step, the present undulatory theory of sound, as elucidated by the distinguished authorities." It is furthermore said that Dr. Hall has shown that the current acoustical theory contains numerous fallacies, and, from the language adopted throughout the book, we should infer that it is shown to be childish, absurd, and wholly unworthy of credence. Dr. Mott avows his agreement with Dr. Hall, and he gave a lecture before the New York Academy of Sciences, December 8, 1884, stating Dr. Hall's objections to the present theory of sound, and this lecture constitutes the volume before us. Dr. Mott says that the work of exploding this theory has already been pretty well accomplished, and in his preface he gives the names of divers presidents of colleges, and professors thereof, from California to New Hampshire and South America, who have accepted "Dr. Hall's discovery," and abandoned as baseless and worthless the hitherto accepted wave theory of sound.

We can not here state Dr. Hall's case as re-expounded by Dr. Mott, but discharge our duty by informing all who are concerned about it where they can get instruction upon the subject. Nor have we formed any opinion, from having examined the arguments, whether the wave theory of sound has been exploded or not. There is getting to be such a free use of dynamite in these latter days among the supposed fundamentals and essentials of science, and long-established opinions seem so liable to sudden overthrow, that we are losing our interest in the operations. Perhaps the safest rule to follow in these revolutionary circumstances is to abide by long-tested principles until given up by those longest and most profoundly trained in the work of scientific investigation.

SCHOOL BULLETIN YEAR-BOOK OF THE STATE OF NEW YORK, FOR 1885. By C. W. BARDEEN. Syracuse, N. Y.: C. W. Bardeen. Pp. 160.

THE "Year-Book" is intended to serve as a convenient educational directory for the State of New York. It contains sketches of the county superintendents and county commissioners, and a list of the principals of village schools and academies arranged by counties. Every alternate leaf is left blank, for the insertion of notes, additions, and corrections.

OBITER DICTA. New York: Charles Scribner's Sons. Pp. 232.

THIS is a collection of essays, which may be called critical or discursive, according to the mood of the reader, on "Carlyle," "Mr. Browning's Poetry," "Truth - Hunting," "Actors," "A Rogue's Memoirs," "The Via Media," and "Falstaff." They embody the "gratuitous opinions" of one who seems to be an independent thinker, forcibly and often very pungently expressed. Each essay has its own quality; that on "Falstaff" is a fund of humor; and they are all pleasant reading.

THE SUN AND HIS PHENOMENA. By the Rev. T. W. WEBB. New York: Industrial Publication Company. Pp. 80. Price, 40 cents.

NOTWITHSTANDING the multiplicity of popular treatises on astronomy, the author has thought there might still be room for a description of the sun, which, confining itself to a brief but careful enumeration of its phenomena, may be found serviceable in elementary instruction. The most recent discoveries are taken notice of.

A CATALOGUE OF CHEMICAL PERIODICALS. By H. CARRINGTON BOLTON, Ph. D., Professor of Chemistry, Trinity College, Hartford, Conn. Reprint from Annals New York Academy of Sciences. 1885. Pp. 58, 8vo.

THIS bibliography contains the titles of the chief chemical periodicals of all countries, from the rise of this literature to the end of 1884. The titles number 182, and eight languages occur; the arrangement is strictly alphabetical by the first word; cross-references are freely introduced, from the editors' names to the journals published by them, and from the chemical societies to their publications. Bibliographical details are quite full; the different titles borne by a periodical at different periods are arranged in chronological order under the first or earliest title. At the end of the paper is a geographical index, arranged by countries and cities.

The material for this bibliography has been drawn for the most part from a larger "Catalogue of Scientific and Technical Periodicals—1665–1882," by the same author. The larger comprises, we understand, over 5,000 titles, and forms a volume of nearly 800 pages; it will be published by the Smithsonian Institution in a few weeks.

The present catalogue will be useful to chemists, and especially to librarians.

BULLETIN OF THE PHILOSOPHICAL SOCIETY OF WASHINGTON. Vol. VII. 1884. Washington, D. C.: Judd & Detweiler. Pp. 135.

THIS volume contains the minutes of the society and of its mathematical section for 1884. The society continues to show a vigorous growth. The total number of members enrolled, from the beginning in 1871, is 292. Thirty-five new members were added during the year, and the present number of active members is 173. The annual address of the president, James C. Welling, delivered December 6, 1884, was on "The Atomic Philosophy, Physical and Metaphysical." The "Minutes" include, besides this address in full, abstracts of the papers read at the stated meetings of the society, among which we notice, as of current general interest, Mr. Russell's on "The Existing Glaciers of the High Sierra of California," Mr. Kerr's on "The Mica-Mines of North Carolina," Mr. Russell's on the "Volcanic Dust of the Great Basin," Mr. Dall's on the "Volcanic Sand that fell at Unalaska in 1883," with Mr. Diller's on the composition of that dust; and Mr. Dutton's on "The Volcanoes and Lava-Fields of New Mexico."

HOW SHOULD I PRONOUNCE? OR, THE ART OF CORRECT PRONUNCIATION. By WILLIAM HENRY P. PHYFE. New York: G. P. Putnam's Sons. Pp. 305. Price, $1.25.

THE author assumes that the subject of English pronunciation has not, as yet, had its main facts and principles clearly and concisely presented; and that, among existing books, none consider the question embraced in the title of the present one in its broadest sense, and endeavor to give it an intelligent and satisfactory answer. His effort has been to supply this lack; to furnish the reasons for the directions given, and to indicate the means of becoming proficient in the very important art. After an introductory chapter presenting general views and principles, the topics are considered of the physical nature of sound, the nature and use of the vocal organs, articulate sounds, the sounds of the English language, alphabets, and the English alphabet. The last topic is followed by complete lists of the various sounds for which each letter in the English alphabet stands, and of the various symbols used for each elementary sound, which are claimed to be the fullest that have ever appeared. Then come rules and suggestions for becoming proficient in English pronunciation and the indication of the correct pronunciations, according to both Webster and Worcester, of more than one thousand words that are frequently mispronounced. Proper names are considered in another chapter, and a bibliography of the subject is given in an appendix.

THE LENAPÉ STONE: OR, THE INDIAN AND THE MAMMOTH. By H. C. MERCER. New York: G. P. Putnam's Sons. Pp. 95. Price, $1.25.

IN 1872 a young farmer in Bucks County, Pennsylvania, turned up in plowing a "queer" stone, which he took home and threw into a box with his other "Indian curiosities." It was a piece of a broken "gorget-stone," on which could be discerned

carved lines, describing the outline of a mammoth. In 1881 he sold it in a lump with his other specimens to Mr. James Paxon, for the round sum of $2.50. Shortly afterward, a smaller fragment was found, which, joined to the former one, completed the gorget, and also the design of a party of Indians hunting a mammoth. The question necessarily arises, Is the stone with its tracings a genuine aboriginal relic? It is a very important one in American archæology. There appears no reason to doubt the entire honesty of all the persons who are known to have handled the specimen. Unfortunately, the stone itself is not capable of giving evidence; for it was not seen, scientifically, till it had been cleaned two or three times, and its possessors had scratched over the lines to make them plainer. Its occurrence where it was discovered is unaccountable if it is not genuine. It has been submitted to experts in aboriginal relics, and they have expressed different opinions respecting it. Three other carved stones have very recently been found on the same farm, the examination of which and their comparison with this one may throw some light on the subject. Mr. Mercer presents the evidence on both sides with seeming impartiality, but evidently believes in the genuineness of the stone.

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Report of the Assistant Director of the U. S. National Museum, for 1883. Washington: Government Printing-Office. 1885. Pp. 200.

The Coöperative Commonwealth. By Laurence Gronland. Boston: Lee & Shepard. 1884. Pp. 278. Cloth. $1.

"The Museum: An Illustrated Monthly Journal for Young Naturalists and Collectors." Edwin A. Barber, Editor. May, 1885. 1220 Sansom Street, Philadelphia. Pp. 16. 15 cents a copy; $1.50 a year.

"Mind in Nature: A Popular Journal of Psychical Medicine and Scientific Information." Monthly. Chicago: Cosmic Publishing Company. March, 1885. Pp. 16. $1 a year.

Experimental Investigation of the Reactions of Various Copper Salts with Grape-Sugar. By George Hay, M. D. 1885. Pp. 6.

American Languages, and why we should study them. By Daniel G. Brinton, M. D. Philadelphia: J. B. Lippincott & Co. 1885. Pp. 23.

The Imported Elm-Leaf Beetle. Bulletin No. 6, U. S. Department of Agriculture. Washington: Government Printing-Office. 1885. Pp. 18. Illustrated.

Revolution in the Practice of Medicine. By John F. Bouton, M. D. Chicago: Review Printing and Publishing Company. 1885. Pp. 55. 25 cents.

A Catalogue of Chemical Periodicals. By H. Carrington Bolton, Ph. D. Author's edition. 1885. Pp. 58.

Luck of a Wandering Dane. By Hans Lykkejaeger. Philadelphia: Metiack & Harvey, Printers. 1885. Pp. 130. 25 cents.

The Crime of Poverty. An Address delivered at Burlington, Iowa, April 1, 1885. By Henry George. Pp. 15.

Population by Ages. Baltimore. 1885. Pp. 30.

The Life of an Oyster. By Professor Samuel Lockwood, Ph. D. New York. 1885. Pp. 12.

Thirteenth Annual Report of the Directors of the Zoölogical Society of Philadelphia. Philadelphia. 1885. Pp. 16.

Address delivered at the Convocation of McGill University, April 30, 1885. By Professor D. P. Penhallow, B. Sc. Pp. 8.

Bacterial Pathology. A Series of Papers on the Exhibits at the Biological Laboratory of the Health Exhibition. Reprint from the London "Lancet." New York: The Industrial Publication Company. 1885. Pp. 48. 25 cents.

"The Sanitary Monitor; a Monthly Journal devoted to Individual, Family, and Public Health." Edited by J. F. Winn, M. D. Richmond, Va. Pp. 14. $1 a year.

Bureau of Education: Planting Trees in School-Grounds, and the Celebration of Arbor Day, pp. 64; and City School Systems in the United States, pp. 207. Washington: Government Printing-Office. 1885.

Ovulation and Menstruation considered in their Physiological Relations. By Franklin Townsend, M. D. Albany: Burdick & Taylor, printers. 1885. Pp. 18.

Scarlet Fever. By T. G. Comstock, M. D. New York. 1885. Pp. 19.

The Taensa Grammar and Dictionary: A Deception exposed. By D. G. Brinton, M. D. From "American Antiquarian." Pp. 4.

Clinical Studies of the Incipient Stages of Inebriety. By T. D. Crothers, M. D. 1885. Pp. 12.

On the Acquisition of Atmospheric Nitrogen by Plants. By W. O. Atwater. Pp. 24.

On the Vanadates and Iodyrite from Lake Valley, New Mexico. By F. A. Genth and Gerhard von Rath. 1885. Pp. 13.

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Recent American Socialism. By Richard F. Ely, M. D. Baltimore: Johns Hopkins University. 1885. Pp. 74.

On the Evidence that the Earth's Interior is solid. By Dr. M. E. Wadsworth. Pp. 24.

History and Management of the Land Grants for Education in the Northwest Territory. By George W. Knight, Ph. D. New York: G. P. Putnam's Sons. 1885. Pp. 175. $1.

Memoirs of the National Academy of Sciences. Vol. II, 1883. Washington: Government Printing-Office. 1884.

The Figure of the Earth. By Frank C. Roberts, C. E. New York: D. Van Nostrand. 1885. Pp. 95. 50 cents.

Photo-Micrography. By A. Cowley Malley. London: H. K. Lewis. 1885. Pp. 169.

The True and Romantic Love-Story of Colonel and Mrs. Hutchinson: A Drama in Verse. By J. Antisell Allen. London, E. C.: Elliot Stock. Pp. 88.

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POPULAR MISCELLANY.

The American Association.—The next meeting of the American Association is appointed to be held at Ann Arbor, Michigan, beginning August 20th. The Association at its last or Philadelphia meeting expressed a preference for Bar Harbor, Mount Desert, as the place of its next meeting, if suitable accommodations could be secured there, naming Ann Arbor as an alternative place. It has been ascertained that, while hotel-room is not wanting at Mount Desert in July and the latter part of September, all possible accommodations are taken up at the time the Association would meet, in August. At Ann Arbor, the university buildings and the rooms usually occupied by the students will be at the disposal of the Association.

The British Association.—The arrangements for the coming meeting of the British Association at Aberdeen, September 9th, are nearly completed. The president-elect for the year is Sir Lyon Playfair. The general secretaries are Captain Galton and Mr. A. G. Vernon Harcourt, while Professor Bonny serves for the last time as acting secretary. The presidents of the various sections are: A, Mathematical and Physical Science, Professor G. Chrystal; B, Chemical Science, Professor H. E. Armstrong; C, Geology, Professor J. W. Judd; D, Biology, Professor W. C. McIntosh; E, Geography, General J. T. Walker; F, Economic Science and Statistics, Professor Henry Sidgwick; G, Mechanical Science, Mr. Benjamin Baker; H. Anthropology, Mr. Francis Galton. The lecture to working-men will be delivered by Mr. Harold B. Dixon, on "The Nature of Explosives." The other lectures will be by Professor Grylls Adams, subject not announced, and Mr. John Murray, director of the Challenger Expedition Commission, on "The Great Ocean Basins."

How Floras are changing.—Professor C. E. Bessey notices, in the "American Naturalist," on the subject of "Plant Migrations," a few instances in which certain plants have disappeared from the flora of a part of Central Iowa, to have their places taken by other species coming in from abroad. Fifteen years ago the *Dysodia chrysanthemoides* grew by the road-side in great abundance; now it is scarcely to be found, and is replaced by the introduced "dog-fennel," or "May-weed" of New England (*Anthemis cotula*). Then, the small flea-bane (*Erigeron divaricatum*) abounded on dry soils; now it is rapidly disappearing. Mulleins have begun to appear, and the squirrel-tail grass (*Hordeum jubatum*), which had no place in the flora, is very abundant, and has been for ten years. The low amaranth (*Amarantus blitoides*), which was rarely found, is now abundant, and has migrated fully one hundred and fifty miles northeastward. Bur-grass, also, a most offensive plant, has come in, and appears to be rapidly increasing. Professor Bessey is informed by old settlers that in Nebraska the buffalo-grasses were formerly abundant in the eastern part of the State, but have now retreated for a hundred or a hundred and fifty miles, while they have been followed by the blue-stems (*Andropogon* and *Chrysopogon*), which now grow in great luxuriance all over the plains, where twenty years ago the ground was practically bare. The same is taking place in Dakota.

Color of Arctic Animals.—Mr. Wallace's theory that the white color of many Arctic animals is due to protective adaptation or mimicry has been disputed by Mr. Meldola, who speaks of some Arctic animals that are not white, and regards that color as having some relation to the radiation or absorption

of heat. Mr. Wallace, defending his view, says that, "if the white coloration of the Arctic animals stood alone, it might be thought necessary to supplement the protective theory by some physical explanation, but we have to take account of the parallel cases of the sand-colored desert animals, and the green-colored denizens of the ever-verdant tropical forests; and, though in both these regions there are numerous exceptional cases, we can almost always see the reason of these, either in the absence of the need of protection, or in the greater importance of conspicuous covering. In the Arctic regions the exceptions are particularly instructive, because in almost every case the reason of them is obvious." The Arctic wolf does not turn white, because he hunts in packs, and concealment is not necessary; the musk-sheep, yak, moose, caribou, and reindeer are able to take care of themselves, and need no protection or concealment. The glutton and sable are dark-colored because they live in trees, and must look like them. The raven, living on carrion, requires no concealment, and continues black. Mr. Wallace is of the opinion that color has very little to do with the absorption or radiation of heat, because those matters are largely determined by the structure and surface-texture of the colored substances.

A Mystery of the Growth of Trees explained.—Mr. John T. Campbell relates in the "American Naturalist" his discovery of one of the causes of the phenomenon of particular tracts of land being covered with a simultaneous, nearly exclusive, growth of trees of a particular species. Some have ascribed the phenomenon to a peculiar fitness of the soil to particular kinds of vegetation, which he does not find to exist. His own explanation is very simple, and is to the effect that the matter lies wholly or mainly in the fact of the ground being in a fit condition to receive the seeds of the various species when they fall upon it. Seeds of different kinds fall at various seasons, and when the ground is in various conditions as to moisture, etc. Those that find the ground in good condition sprout and grow, if no accident occurs to remove the plants when very young. Mr. Campbell has tested this view in his surveys in the occasionally flooded bottom-lands of the Wabash River, and illustrates it by following the futures of the seeds of three species of trees. The balls of the sycamore or button-wood begin falling early in the spring months, and, if a flood is receding at the time, they stick to the soft, moist banks wherever they touch them, and particularly along the highest parts of the sand-bars. Were it not for the subsequent floods in the same spring, no other trees could grow, for these would occupy the ground. But they are easily killed during their infancy by overflows, and this is what happens to most of them. The cottonwood is the next in order of shedding seed, and, if another flood is receding while this is taking place, it will have killed all the sycamores which it has covered, and sprout the cottonwoods. These in turn may be killed by the next flood. It is the turn of the maples next to shed their seed, and try for the ground. If either of these species succeeds in making wood without a flood, it will hold the ground, and its rivals will not be able to get a place. Last spring the edges of the successive plantations escaped the next floods after the seeds fell upon them, and Mr. Campbell could see along the river-banks three belts of young trees, and distinguish them by their general appearance. The upper belt was of sycamore, the second (downward) of cottonwood, and the third of soft maple. In June a bigger flood came than any that caused the seeds to sprout, and killed all the young trees.

Water-Melon Sirup.—In response to the inquiry by Dr. H. Carrington Bolton concerning the manufacture of sugar from water-melons (see June number, page 287), Mr. E. A. Gastman, of Decatur, Illinois, writes as follows: "About 1842 the manufacture of molasses was carried on here in Central Illinois from melons. I do not know how extensive nor how successful it was, but I remember very clearly when a boy on the prairies near Bloomington that our neighbors frequently raised large crops of water-melons, from which they made molasses." It will be observed that the extract from Boyle's work communicated by Dr. Bolton mentions a "sirup," not sugar.

Madness and Crime.—In an address on "Madness and Crime," delivered some months ago, Mr. Clark Bell called attention to a condition of insanity under which crime is sometimes committed which is not recognized by the law and is not often taken notice of by the courts. It is the condition that exists when the man is perfectly aware of the nature of the act he commits, and of the fact that it is prohibited by the law and is punishable, but is at the same time incapacitated by mental disease from controlling his own conduct. The most careful discussion of the question has been made by Sir James Stephen, who has proposed as a solution of it the authorizing of juries to bring in a special form of verdict where the existence of such conditions has been proved. It has also doubtless been the element of the case which has often prompted American juries to bring in some of those singular verdicts which have caused remark as contrary to the law and the facts. In Mr. Bell's opinion, "the time has come when legislators must face this question upon its merits. The able and masterly manner in which Sir James discusses it, the decisions in many of the American States recognizing a different test for responsibility, call for a settled law both in England and America, which would be in accord with the principles of justice and commensurate with the civilization of our age. . . . There is no doubt whatever that the uncertainty of verdicts is largely due to the popular conviction of the injustice of the law as it now exists, and as it is frequently construed by the courts. . . . It is a legislative and not a judicial question, and must receive public attention commensurate with its great importance in the administration of criminal jurisprudence."

Sorghum and Beet Sugar in the United States.—Professor H. W. Wiley, chemist of the Department of Agriculture, in his report on "Northern Sugar Industry," gives the amount of sorghum-sugar manufactured at the principal factories in the United States during the season of 1883 at 726,711 pounds. The factories are at Rio Grande, New Jersey; Champaign, Illinois; Sterling, Hutchinson, and Ottawa, Kansas; and the Department of Agriculture. The largest and most successful factory is at Rio Grande, near Cape May, New Jersey, where the soil and climate appear favorable to the production of the crop. A careful calculation leads the author to estimate that the average amount of sugar which can be obtained in marketable form from sorghum is 4·75 per cent by weight of the expressed juice, or 2·37 per cent, or 46·4 pounds per ton, of the cane. Besides this, two other sugars than the crystallizable sucrose are present in the juice, but they are not separable in solid form, and enter into the molasses. This yield is proportionately very large, and, if the production of sorghum-sugar should be carried on with success enough to make it a staple crop, the product of molasses will be greater than ordinary consumption can dispose of. The only other uses to which the molasses can be put will be as food for animals and for distillation; and the latter will be the more money-making. Each gallon of molasses will give a gallon of commercial alcohol. Happily, this kind of alcohol is said to be only fit for use in the arts. Professor Wiley remarks that the fact must be admitted that the present production of sorghum-sugar is not very encouraging after thirty years of endeavor; but nearly all the progress that has been made in it has taken place during the last three years. The outlook is better for the manufacture of beet-sugar, which is pronounced an assured success on the Pacific coast. The five years' experience at the Standard Sugar Refinery, Alvarado, California, is claimed to have proved that beets raised in that State will yield as many tons per acre and are as rich in saccharine matter as any raised in Europe. During the season of 1883–'84 there were produced at this establishment 1,027,826 pounds of white refined sugar, while there were still in tanks at the time of making the report, in process of crystallization, 250,000 pounds more.

Corrupt Legislation.—The causes of the defective and corrupt legislation which appears to be one of the crying complaints of the present time have been reviewed in a short pamphlet by Mr. Simon Sterne, who also makes a general suggestion of a remedy for them. The causes lie in the methods of procedure of our legislative bodies, which are unsystematic, hasty, and uncon-

sidered. The public good is often the thing least thought of. On the other hand, the predominant general motive is the desire of the party in power to keep the other party out; and each member of the body has some "axe to grind," either his own, or the axe of his constituents or of some private or corporate interest. The same was the case in England, till the passage in 1848 of the "standing orders," by which a complete separation was effected in the method of treatment of public and of private and local bills. Public bills are now placed under the wing of the Cabinet. Private and local bills are no longer treated as legislation, strictly speaking, but as petitions to Parliament for special immunity or privileges which are conducted by private parties, and are subject to a strict rule of procedure. They are tried as a lawsuit, in which the petition and bill are filed before the beginning of the session, "and opposed at every step, as a whole and in detail, by the Board of Trade and by every private interest which may be menaced or affected thereby. Counter-petitions, attorneys, counsel, and a trial, a standing and a day in court to all parties in interest before the bill can become a law, prevent wrong to individuals; counsel for the ministry for the public bills, and special counsel for the private bills, committees to aid them in the intelligent discharge of their work, prevent the possibility of working, by collusion, a public wrong." The details of these measures, which we have not space to follow, are carefully adjusted to secure their successful working. The prohibition of special legislation, which has been incorporated into some of our State Constitutions, is regarded by Mr. Sterne as unphilosophical; for there must always be exceptional cases which general legislation can not cover, but for which special provisions are necessary; and it is this need which is recognized in the British system. The prohibition, moreover, defeats itself, for it is evaded, and worse measures are passed for special ends, under the pretense of generality, than could succeed if they were presented in their real character. Mr. Sterne has proposed a detailed plan for a system of legislative procedure, modeled after the British "standing orders," which deserves at least to be thought over.

British Hens and Eggs.—By actual count (for a census has been taken), Great Britain and Ireland contain thirty million head of poultry of all kinds, twenty million of which may be classed under the head of "chickens." The laying hens, which may be estimated to constitute one fourth of the chickens, or five million head, may lay from seventy to two hundred eggs a year. It is safe to average the number at from eighty to one hundred for each hen. This would give four or five hundred million eggs a year. Between a third and a half of the whole stock of poultry are consumed every year. Some of the English cottages derive as much as twenty-two pounds, or a hundred and ten dollars a year, from their fowls, half of which is profit. The poultry are bought up lean by "higglers" or "hagglers," and are fattened for the market by "crammers," who make this their special business. The feeding is performed by machinery, by a rapid process, and the trade is a growing one. The home supply being estimated at eight million chickens a year, and the fowls being valued at two shillings each, we have an annual market value for this stock of £800,000, or $4,000,000. This does not include the turkeys, ducks, and geese, of which eight million are returned in Great Britain and Ireland. If the same proportions of these are brought to market as of chickens, rating them at five shillings a head, we may, by adding the proceeds from them, raise our poultry account to £1,000,000, or $5,000,000. It is impossible to calculate the number of eggs that are consumed in the United Kingdom. If twenty million of the population eat an egg a week, that would be ten hundred and forty millions a year. It is known, however, that during 1883 there were imported nine hundred and forty million four hundred and thirty-six thousand one hundred and sixty eggs, and they were worth £2,732,055, or five times as many dollars; and up to the end of August, 1884, six hundred and eighty-one million six hundred and eighty-three thousand and forty had been received. The home hens are supposed to furnish five hundred million eggs. Adding these to the foreign supply, and valuing the whole at a penny an egg, we have Great Britain's egg bill, £6,250,000, or $31,250,000.

How Yakuts make a Fire.—The process of starting a fire employed by the Yakuts and Tungases of Northern Siberia is quite elaborate, and is thus described by Commander Mellville in his "The Lena Delta": "To start the fire, a dry piece of wood is procured from the high river-banks, many sticks being cut with the axe and rejected until one entirely free from moisture and fit for kindling is found, which is then carefully split and kept dry. The best of the drift-wood is next selected and also split up and chopped into proper lengths. Thus far, so good: but the natives are ignorant of matches, and with only their flint and steel it would seem a difficult matter to start a fire, since they have no rags, either cotton or flax, or any highly inflammable material like sulphur-sticks. But here is where the Yakut and Tunguse ingenuity asserts itself. The buds of the Arctic willow are forever trying to peep from beneath their thin blanket of snow, and within these buds is a light flossy substance in the nature of thistle-down. Whenever he can, the native gathers a handful of these, and robs them of their down, which he then moistens slightly and mixes with ground charcoal, prepared by cooling a lighted piece of birch-wood in the ashes of his hearth. The dampened floss heavily rolled through the charcoal is next covered up and dried before the fire on the same board whereon it was pounded and the charcoal powdered. It is now an excellent tinder, igniting quickly into a hot and durable point of fire. But, in addition to it, some light match-stuff is necessary, and, to supply this need, a bundle of fine soft sticks, about thirty inches long, is always kept drying over the fireplace. Before the native sets out on a journey, or, indeed, as often as material is required, the old women of the house take down several of these sticks and carefully shape them into sword-blades. They then rest their knives in beveled notches cut in the flat sides of small pieces of wood, about three eighths of an inch broad, one eighth of an inch thick, and one inch and a half long, and the operation proper begins. Along the wooden sword, which is held against the shoulder like a violin, the knife in its gauge is drawn continuously and rapidly, and at each draught a thin coiling shaving drops to the floor or into the lap of the operator. A bag full of these fine curls —which, when matted together, very much resemble the American manufactured material known to upholsterers as 'excelsior'—is always ready for the traveling native, preserved dry in the huts beneath the sleeping-skins, and carried in a fish-skin bag on the journey. So, now, with the materials at hand, we will start a fire. The native takes from his skin pouch a bunch of the 'excelsior' about the size of a robin's nest, rolls it into a ball, punches a hole in it, and then lays it carefully in the snow. Next, taking a pinch of tinder from the bag which always hangs at his hip, he places it on his flint, and with a quick sharp stroke ignites and incloses it in the center of his nest of shavings, which he then lifts up, holding it lightly with his fingers spread apart for the passage of air, and whirls rapidly around his head at arm's length. At first, a faint, pleasing odor of burning birch steals upon the air, then a light streak of smoke follows the revolving arm, and then the heat within his hand notifies the native that a proper degree of ignition has been attained; he suddenly ceases his gyrations, tears open the smoking nest, and with a quick puff blows it into flame. Then depositing the blazing ball on the snow, he soon piles his fagots over and around it, and in few seconds his fire is in full blast."

Religion and Inebriety. — Dr. T. D. Crothers, considering the question whether faith and prayer, or honest intention on the part of the patient, can alone save him from inebriety, expresses his opinion as in the negative, and says: "In a study of ten cases on this point, I found that seven had been, before and after the beginning of inebriety, active church-members, had experienced conversion and led active lives of faith and prayer for longer or shorter intervals, depending on circumstances. Two of these were periodical inebriates, and had, during the free intervals between the attacks, led a most consistent Christian life of faith and prayer. One of the seven exhibited the strange delusion of religious mania when drinking; at all other times he was a quiet skeptic and doubter, but, when once under the influence of alcohol, he was the most ardent religious devotee, exhorting with

great enthusiasm, and asking the prayers of every person he met, to save him. His mind seemed troubled with intense fear of failing to get to heaven, and every thought and exertion seemed directed to this end; but secretly he drank constantly, never to be stupid, but just enough to keep up a degree of excitement. This would last two or three weeks, then merge into a low form of nervous fever, from which he would recover and remain sober for an indefinite time. . . . The other three had been good church-members before inebriety came on, but on becoming inebriates left the church." Another case was that of a clergyman whose inebriate fits always began when he was administering the wine at the communion. After quoting a few other cases, pertinent but of not quite so striking a character, Dr. Crothers states his conclusions, which are according to the view he has steadfastly held, that "inebriety is a physical disease which must be reached by both physical and psychical means. All methods of treatment must be along the line of natural laws, and include all means, both physical and spiritual, that can build up and strengthen the entire man. Spiritual means are only valuable as they are used with other means, and where they are effectual alone they are the exception to the rule, and can not indicate any direct line of treatment."

Butcher's-Meat and Headaches.— The prescription of a diet largely vegetarian has long been known to be good for persons subject to attacks of headache. Dr. Alexander Haig relates, in "The Practitioner," a case that came under his treatment which indicates to him that this disease and its attendant phenomena are largely the result of a poison circulating in the blood, which poison is a product of the digestion of certain foods, especially butcher's-meat; and that a cure is best effected by cutting off entirely the noxious food, and aiding the elimination of the poison by the kidneys. The patient was a chronic sufferer from headache, and the afflictions that usually accompany it. He was a hard student, and was most troubled in winter. On the adoption of a strict vegetarian diet, the attacks, which had been severe, ceased at once, and for six months of the cold half of the year there were only one or two slight ones, although they had been recurring weekly. A less strict diet was subsequently allowed, and gave practical immunity, provided butcher's-meat was avoided. It was also found that two or three tumblers of hot water taken every night at bed-time gave increased immunity, and enabled the patient to take even a little butcher's-meat occasionally without fear of an attack. The disease was evidently caused by impure blood, and that by imperfection of the digestive process. The connection with butcher's-meat was indicated directly by the facts in the case. It may be accounted for possibly by reference to Dr. Michael Foster's suggestion that the pancreatic digestion of the proteids in excess is accompanied by the development of bacteria giving rise to fermentative changes; or by the suggestion made in "Le Progrès Médical," that alkaloids are formed in the intestines during digestion similar to those that have been found in the cadaver, and, if they are absorbed in excess, or are not excreted by the kidneys, cause disorders.

Another Side to the Clothes Question.— "An Anthropologist" protests, in the "Pall Mall Gazette," that, if an attempt is made to impose European clothing on the natives of New Guinea, they will all be killed off. It is clothes, he asserts, and not liquor or immorality, that has been fatal to so many natives of tropical countries. The Australians and Tasmanians have been clothed, and exterminated, while the North American Indians have been left in their traditional costumes, and thrive. This matter of the natural garb of savages is one "in which Nature can not be safely tampered with. Whether tribes are found clothed only with a loin-cloth, or only with paint, it is the result of a long evolution, an adaptation to environment, and no foreigners should go among such peoples who can not adapt themselves mentally and morally to customs representing that environment. . . . In the day that these natives of New Guinea begin to clothe themselves beyond what has sufficed for their health, 'they will surely die.' The exact reason for this has not been satisfactorily shown, though I have been told in several places that clothing checks some

delicate secretions of the dark skin in warm countries. . . . The germs of European vices are carried too often with European clothes. It is a fact significant of more than female conservatism, to which Mr. Herbert Spencer attributes it, that generally the women of a nude tribe are the last to adopt the fashion of putting on clothes. They are always reluctant, and sometimes show such shame in their first dress as a European would feel without clothing. In many parts of India there is a profound suspicion of the irreligiousness of clothing. The fakir is distressed even by the regulation rag upon which the Government modestly insists, and a fully dressed fakir would be scouted. The late Brahmo minister, Keshub Chunder Sen, expressed the belief that India would never accept a Christ in hat and boots. The missionary should remember that clothes-morality is climatic, and that, if a certain degree of covering of the body has gradually become, in the Northwest, associated with morality and piety, the traditions of tropical countries may have equally connected elaborate dress rather with the sensualities of Solomon in his glory than with the purity of the lily as clothed by Nature."

Persian Carpets.—According to a report by Consul-General Benjamin, of Teheran, the Persian carpets, the manufacture of which constitutes one of the most important features of the industries and commerce of the country, are woven chiefly by the women and children of the peasantry in the villages. A countryman will have a rug made in his own house, and will then take it to the nearest town and sell it for what it will bring. The rooms of the peasantry are small, and hence the rugs are commonly small. Of late years, a larger carpet has been manufactured for the foreign market. Four kinds of carpets are made, large ones and small ones or rugs, the *ghileems*, and the *umads*, or felt carpets. Most of the carpets intended for the covering of floors, of whatever size, are produced in the central province of Irak and in the districts of Sarravend, Garrouste, and Malahir, and are known by the generic name of *pharaghan*. They are more solid and massive than other Persian carpets, and are adapted for rooms of large size. Large Persian carpets, which deviate from the usual shape, are made to order, and for an increased price. There are numerous varieties of Persian rugs. In some classes, such as Turkoman, there is general similarity of design, although no two rugs are altogether identical. In other classes, such as the rugs of Kerwan, Dyochegan, or Kurdistan, there is endless variety in design or texture. The colors formerly used in the rugs of Persia were imperishable, and rugs a hundred years old show no deterioration in tint. The introduction of aniline dyes at one time threatened the ruin of the manufacture of textile fabrics, but the use of those dyes has been forbidden by law. The *ghileem*, which is largely made in the province of Kurdistan, has a pattern identical on both sides, with firm and brilliant colors, and designs often of extraordinary beauty. Their lightness and flexibility qualify them for *portières* and table and sofa covers, and render them easy for transportation. The *namáds*, or felt carpets, are made by forming a frame of the thickness required, or by excavating a space in the ground-floor of a size and depth corresponding with those of the intended fabric. The hair is laid in this and beaten out with mallets, and a design of colored threads is then beaten into the upper surface. Silk rugs are peculiar to Persia, and are rare and expensive, although rugs of the finer types, with silken fringes and sometimes with a woof of silk in the body of the rug, are not uncommon.

Brazilian Oranges. — Oranges flourish and are profitable in all parts of Brazil, and the exportation of them amounts to several millions annually. The Umbigo, the favorite variety at Bahia, is without seeds, large, sweet, and delicious, begins to ripen about May, and lasts till September. The most common and popular kind at Rio Janeiro is the Siletta, which has a sweet and delicate flavor. The Tangerina is a smaller variety than the Siletta, many-seeded and ripening at about the same time, and has a deep orange-colored skin that breaks easily in peeling, with an aromatic odor. The orange-orchards are generally situated on low and sandy land, convenient to transportation by water. The trees are planted along from February to May, about fifteen feet apart,

and begin to bear in about five or six years, yielding then from twenty to thirty oranges each, and increasing their crop for ten years till in full bearing, when they produce from two to three hundred, and, in most favorable circumstances, one thousand oranges a year. The trees remain fruitful for more than thirty years. The cost of cultivating and attending a thousand orange-trees in Brazil is estimated at about seventy dollars a year.

Climate and Vegetation.—In a paper on the relations of climate and vegetation, M. M. Bergsman, of Flushing, reaches the conclusion that a mixed climate, with relatively mild winters and warm, sunny summers, is the best suited for the vegetation of the temperate zone. Corn can be cultivated only as a green vegetable in England; is profitable in Western Europe only to 46°, and in the valley of the Rhine to 49°, but in certain regions of North America to 51°, and even under the Polar Circle in Norway, where it has the sun day and night. Plants much resembling those of Central Europe grow in the Amour region of Siberia, where precipitation occurs only in summer, and that season is warm, in the face of a winter temperature much lower than is observed in the most northern parts of Lapland. Radishes, turnips, rape, and the potato grow as far north as there are settlements, but in the extreme north the potatoes are only as large as walnuts, and the plant never blossoms in Greenland. When comparing extreme continental climates with extreme sea climates, the continental climate has the advantage. The extreme southern limit of phanerogamous plants is in the South Shetland Islands, latitude 60° to 63° south, and the last trace of vegetation, in cryptogams, is found on Cockburn Island, 64° south. At the same latitude in Northern Siberia is a forest of very high coniferous trees. The chief reason that corn can not be cultivated in Siberia beyond 62°, at Yakutsk, is on account of the constantly frozen condition of the ground at a short distance beneath the surface. In Europe, even, the climate of the northern parts of the British Isles is not suited for many vegetables and other cultivated plants. It is in Germany where almost all the plants of the temperate zone and those commonly cultivated can be found. Even in that country the summer temperature in general is only a few degrees above that calculated for the latitude. Germany is crossed in July by the isotherm of 68°, and Britain by that of 59°, but the difference in vegetation is not caused by the difference of 9° in mean temperature, but by the difference in the amount of sunshine.

Denudation of the Continents.—Mr. T. Mellard Reade, addressing the Liverpool Geological Society on "The Denudation of the Two Americas," showed that one hundred and fifty million tons of matter in solution are annually poured into the Gulf of Mexico by the Mississippi River. This, it was estimated, would reduce the time for the denudation of one foot of land over the whole basin—which time has hitherto been calculated solely from the matter in suspension—from six thousand years to four thousand years. Similar calculations were applied to the La Plata, the Amazon, and the St. Lawrence; and Mr. Reade arrived at the result that an average of one hundred tons per square mile per annum is removed from the whole American Continent. This agrees with results he had previously arrived at for Europe, from which it was inferred that the whole of the land draining into the Atlantic Ocean from America, Africa, Europe, and Asia contributes matter in solution which, if reduced to rock at two tons to the cubic yard, would equal one cubic mile every six years.

Photographing Colors.—Professor H. W. Vogel has made a report of the final results of his researches on the means of photographing colored objects in their natural shades. Sensitive plates are affected only by the more refrangible rays, so that they present totally unnatural and distorted pictures, as to the shading, of colored objects. Believing that the sensitive collodion is affected only by such colors as are absorbed by it, Professor Vogel's efforts have been directed to making his plates sensitive to less refrangible rays by alloying the silver coating with a substance capable of absorbing those rays. His experiment succeeded with the natural colors, but he could not obtain an effect with the duller artificial colors. He then sought for organic substances pos-

sessing a power of absorption more intense and lying nearer to the yellow of the spectrum, and obtained in eosine and in various derivatives coloring substances which hard ly possess more than a broad absorption band in the yellow, and with which he obtained the desired result. When these bodies were mixed in due proportions with the dry gelatine plates, the yellow of the colored objects appeared quite clear on the photograph, but the blue was still always brighter. Professor Vogel then inserted a yellow glass between the object and the camera, which partly absorbed the blue rays, leaving the yellow unimpaired, and obtained photographs in which the blue, as well as the green and yellow, and partly even the red, parts of the colored objects presented to the observer's eye the same vivid effects as the original.

The Objects of Bathing.—The object of bathing, says a writer in the "Saturday Review," is fourfold: to produce a certain amount of nervous shock, that should be followed by reaction and an increased circulation of the blood on the surface, resulting in a more rapid change of tissues; to lower the temperature of the body; to cleanse the skin; and to produce pleasurable feelings, and, in connection with swimming, the beneficial effects of one of the best forms of physical exercise. The nervous shock and the reaction from it, following the first contact with the water, are important points, and to obtain them the plunge or the douche is preferable to any other form of bath. To wade up to the middle and stand shivering and fearful of the momentary feeling of discomfort is neither healthy nor pleasant, and timid persons who dare not plunge boldly into the water should be content with the douche-bath. A large garden hose, with a high pressure of water, held at a distance of fifteen or twenty feet from the body, will give an idea of this most delightful curative and bracing agent. Sea-bathing differs from out-door fresh-water bathing in the greater specific gravity of sea-water and its consequent greater buoyancy and more uniform temperature, while the pure air, sunshine, and better sanitary surroundings of sea-side places contribute largely to the results. Mineral baths, as such, have no particular superiority over other baths of the same density and temperature. In addition to the greater healthiness and enjoyableness of out-door bathing, it is probable that the simple exposure of the body to the sun and fresh air is of real benefit, and contributes to the sum total of the good results. Cramps are considered one of the great dangers of bathing, but when they are fatal it is probably the result of syncope or fainting, from failure of the heart's action. A good swimmer in vigorous health would hardly be wholly disabled by a cramp of only a part of his limbs.

Structure of the Edible Birds' Nests.—Mr. Pryer, whose account of his visit to the Gomantin Caves, in North Borneo, has furnished a fund of information respecting the edible birds' nests of the Chinese, has published in a Japan paper an article correcting some misapprehensions that he has found to exist on the subject. That the nests are made from the saliva of the bird he regards as a physical impossibility, for a bird could not secrete in a few days a mass of saliva more than equal, when dried, to the entire bulk of its own body, and then do this nine consecutive times a year. He thinks that some saliva is used by the birds, the algæ being worked up in the bird's mouth in the same manner that mud is worked up by the Japanese swallow. Mr. Pryer at first thought that the black nests owed their color to their being made of the brown outsides of the algæ, while the white nests are made of the inside. This is not correct, for the birds can use only the inside; the black nests are simply white nests grown old and frequently repaired.

How to sleep well.—In sleeping, much depends on securing a comfortable position. Lying on the back would seem to give the most ease, but general experience and practice prove that it does not, and it is liable to some definite objections. In a weakly state of the heart and blood-vessels, and in certain morbid conditions of the brain, the blood seems to gravitate to the back of the head, and to produce troublesome dreams. Persons who have contracted chests, and who have had pleurisy and retain adhesions

of the lungs, do not sleep well on the back. Nearly all who are inclined to snore do so in that position. For these and other reasons, it is therefore better to lie on the side, and in lung-disease to lie on the weak side, so as to leave the healthy lung free to expand. It is well to choose the right side, because, when the body is thus placed, the food gravitates more easily out of the stomach into the intestines. Sleeping with the arm thrown over the head is to be deprecated; but this position is often assumed during sleep, because circulation is then free in the extremities and the head and neck, and the muscles in the chest are drawn up and fixed by the shoulders, and thus expansion of the thorax is easy. The chief objections to this position are that it creates a tendency to cramp and cold in the arms, and sometimes seems to cause headaches and dreams. The best sleep is obtained when the shutters are closed so as to make the room dark, and the windows are adjusted so as to admit plenty of fresh air. Early rising is not a virtue, unless the riser has secured sleep enough; and the best rising is obtained when the sleeper wakes naturally.

NOTES.

THE works of Darwin, Spencer, Agassiz, Huxley, Adam Smith, and Lewes, are said to be forbidden to be issued from the circulating libraries of Russia. The writings of Moleschott, Büchner, Vogt, and Reclus, are also prohibited.

DOIN, of Paris, has begun the publication of a weekly "Journal des Sociétés Scientifiques," which will contain brief reports of the principal scientific societies, in whatever field, of the great cities of Europe. It costs fifteen francs, or three dollars, postage-paid, a year.

M. ALLUARD has frequently noticed, in passing from his observatory on the Puy de Dôme, to the city of Clermont-Ferrand, that, while the air was clear and transparent to the west of the chain of the Puys, it was obscured on the east. On investigation, he found that the obscurity was caused by the dust which the wind, generally blowing from the west, swept up from the rocks over which it passed. This explanation was confirmed by the fact that the fog-like appearance disappeared after a rain.

THE use of artificial teeth turns out to be of ancient origin. Two curious specimens of artificial teeth from the Etruscan tombs, dating from four or five centuries before the Christian era, may be seen in the Museum of Corneto, on the coast of Italy. In the bodies of two young girls, on the jaw of one are still to be seen two incisors fixed to their neighbors by small gold rings, while in the other the rings remain, but the artificial teeth have fallen out. The teeth, carefully cut, had evidently been taken from the mouth of some large animal.

HERR RUDOLPH JALL, of Saarbrücken, Prussia, who has made a special study of volcanic eruptions, states that colliery explosions coincide with or follow closely upon earthquakes. He specifies a number of days during the present season as days which will be dangerous all over Europe.

MR. JOSEPH THOMSON, in the relation of his journey through the Masai country in Africa to the Victoria Nyanza, speaks of his troop in one of its marches having "done" little short of seventy miles within twenty-four hours, without a drop of water or a bit of food!

A COMMITTEE has been formed for organizing the celebration of the centenary of the birth of Arago, which will occur on the 17th of March next.

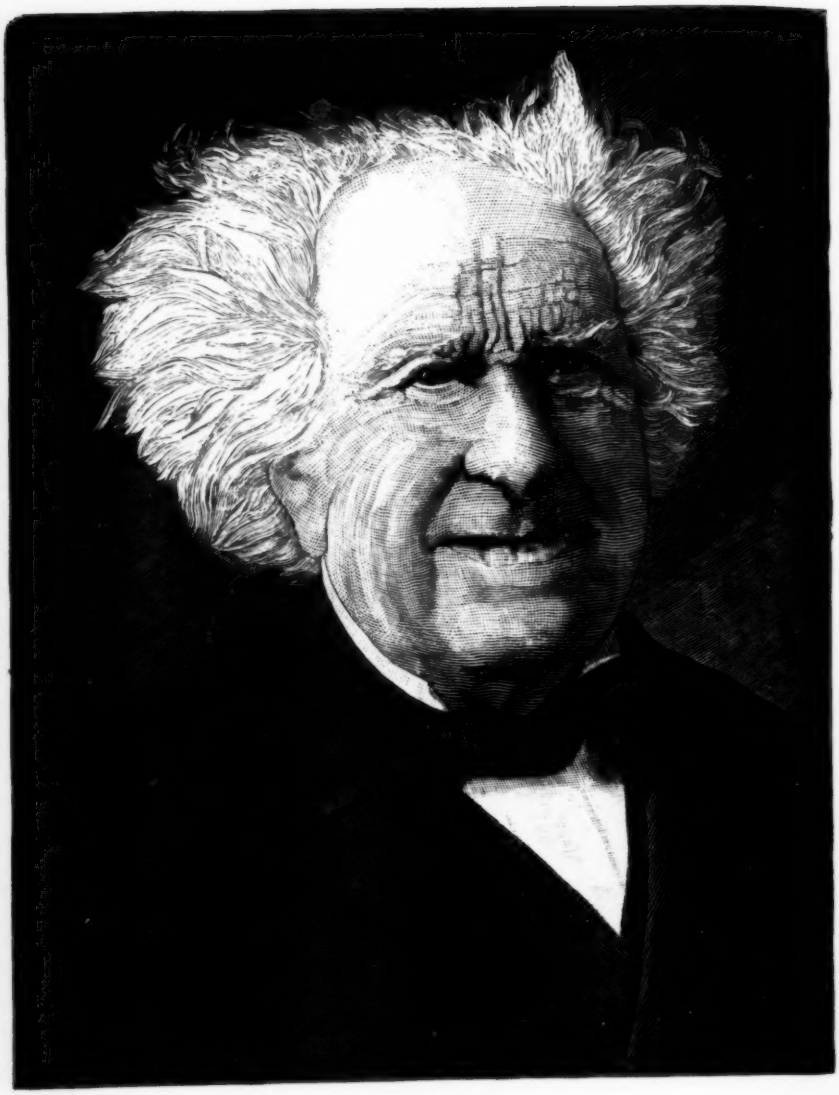
OBITUARY NOTES.

AMONG the deaths of the last few months in the scientific world is that of John Birmingham, astronomer, of Millbrook, Ireland, at the age of seventy-eight years.

IN A. S. Uwarrow, who died a few months ago, Russia has lost one of its foremost archæologists and the founder of the Archæological Society of Moscow. He published works on the archæology of Southern Russia, the tumuli on the Oka (Vladimir), and the Finnish people of the Mesia, who inhabited the country before its colonization by the Russians.

MAJOR F. J. SIDNEY PARRY, one of the oldest members of the Entomological Society of London, died on the 1st day of February.

TITIAN RAMSAY PEALE, the last surviving son of Charles Wilson Peale, the portrait painter of Revolutionary times, died in Philadelphia, March 13th, in the eighty-sixth year of his age. He was a naturalist, and had fine collections of moths and butterflies; was one of the founders of the Philosophical Society of Washington; was a member of the United States Exploring Expedition of Commodore Wilkes; and was the only survivor of Colonel Long's Expedition to the Rocky Mountains.



MICHEL EUGÈNE CHEVREUL.